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ABSTRACT

The Training Effectiveness, Cost Effectiveness Technique for choosing instructional delivery systems for proposed training programs during conceptual design phase is outlined, in three steps. Training objectives are classified and organized into groups, appropriate learning strategies are identified, and the costs of alternative forms of training are projected. Reference materials for carrying out the process are provided, including a list of 12 types of learning algorithms and the class of learning objectives each supports, separate tables for choosing instructional delivery systems for each algorithm, and a cost model for comparing the value of resources required by alternative delivery systems. A Fortran IV program listing of the cost model is included. (SK)

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TAEG REPORT
NO. 16

A TECHNIQUE FOR CHOOSING COST-EFFECTIVE INSTRUCTIONAL DELIVERY SYSTEMS

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13. ABSTRACT

This report presents a technique for choosing cost-effective instructional delivery systems for proposed training programs. It is the Training Effectiveness, Cost Effectiveness Prediction (TECEP) technique. It provides an orderly approach for the skilled training system designer to use in making delivery system choices during the conceptual design phase.

A three-step procedure is described in which training objectives are classified and organized into groups, appropriate learning strategies are defined for each group, media capable of supporting these strategies are identified, and the costs of alternative forms of training are projected. With this information, optimum delivery system choices can be made.

Reference materials are provided to aid the training system designer in carrying out this process. Included are a list of 12 types of learning algorithms and the class of learning objectives each supports, separate tables for choosing instructional delivery systems for each algorithm, and a cost model for comparing the value of resources required by alternative delivery systems. A Fortran IV program listing of the cost model is included.

A series of reports describes the TECEP technique. In addition to this report, two others will be forthcoming. They are TAEG Report No. 23, Learning

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TAEG Report No. 16

A TECHNIQUE FOR CHOOSING COST-EFFECTIVE INSTRUCTIONAL DELIVERY SYSTEMS

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April 1975

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ACKNOWLEDGMENTS

This report is a continuation of the effort to develop a method to identify cost-effective training techniques during the early design stage of training systems. TAEG Report No. 1, Staff Study on Cost and Training Effectiveness of Proposed Training Systems (1972), was the first report in this series of studies. Also, the draft of this final report, A Technique for Choosing Cost-Effective Instructional Media (1974), received a one-year field trial. Refinements were incorporated during this period of field application.

Ideas have been borrowed from others who have worked on the media selection problem. We acknowledge the use of information on task categories and learning guidelines from the work of Dr. M. P. Willis and Dr. R. O. Peterson. From Mr. B. G. Boucher, we have borrowed information on media classes and on basic characteristics of media, and from Dr. R. W. Spangenberg we received general counsel on media selections. We also appreciate the suggestions made by Dr. R. Branson, principal investigator in the Interservice Instructional Systems Development Model and his colleagues Drs. G. Rayner and L. Cox. Charles L. Morris, Jr., formerly of the Training Analysis and Evaluation Group (TAEG), developed an early version of the cost model, which was a stepping stone to the present model. We also acknowledge and appreciate the support of T. F. Curry, a member of TAEG, who coordinated the production of the report.

We are especially pleased to acknowledge the counsel of Dr. Alfred F. Smode. We are indebted to him for his contributions to the TECEP technique and for his efforts in refining the presentation of the material.

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SECTION I

INTRODUCTION

The selection of an instructional delivery system is an important step in the training system design process. An instructional delivery system is made up of the student and all of the elements with which he interacts to achieve instructional goals. The structure of this delivery system determines in a major way how the information pertinent to training is to be organized and presented to the student. The choice of the delivery system affects not only training effectiveness but also the costs of instruction. For example, in the systems engineering approach, instructional delivery system choices are determined from trade-off studies which consider the relevant alternatives for training and the associated costs. Choosing the delivery system with an optimum mix of instructional media is difficult to accomplish in an intuitive, informal manner. A systematic approach to media and instructional delivery system selection is required which is formalized in the training system design process.

Recently, the Training Analysis and Evaluation Group (TAEG) examined the available formal media selection techniques for possible use in Navy training system design. From this grouping, the 10 most promising published techniques were selected and critically examined. None of the techniques was found adequate for use in developing specifications for Navy instructional delivery systems. The results of this investigation are presented in TAEG Report No. 8.[1]

The available formal media selection techniques suffer various shortcomings. All tend to be imprecise (vague, ambiguous terminology) and too gross in categorizing the factors that influence the media selection process. They also lack generality. The available techniques are tailored to specific training environments and are inappropriate to a range of training situations such as found in the Navy. To be workable, they also require considerable intuitive judgments on the part of the training system designer. The existing approaches are incomplete in that they do not account for all the critical variables in the media selection process. Prominent factors that must be considered include the nature of the tasks and task structure, the learning strategies appropriate to these tasks, the media types available for instruction, and the procurement, operating and updating costs of alternative media mixes. Other prominent factors are the state of development of proposed media approaches, resources required for courseware development, and the characteristics of the anticipated student population.

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[1] Richard Braby, An Evaluation of Ten Techniques for Choosing Instructional Media, TAEG Report No. 8, December 1973. Training Analysis and Evaluation Group, Orlando, Florida.

What is needed are means for reducing the weaknesses inherent in existing media selection schemes and to consider all elements of the instructional delivery system. The selection procedure presented in this report, called the Training Effectiveness and Cost Effectiveness Prediction (TECEP) technique, is an attempt in this direction.

This report presents an operational description of the TECEP technique. The ground work for the technique was laid in TAEG Report No. 1.[2] In its present form, the TECEP procedure has incorporated the design requirements for an optimum media selection technique articulated in TAEG Report No. 8.[3] A one-year field trial of the draft version of this report resulted in additional refinements which have been incorporated into this final report. However, the technique continues to possess some of the worrisome limitations ascribed to the previously available techniques. The choosing of an optimum instructional delivery system for various types of military training objectives remains a subtle and complex decision-making task; something that cannot be fully proceduralized. Training system designers who use the TECEP technique must possess expert knowledge of media. The technique will serve as a performance aid in carefully exploring the probable cost and effectiveness of various alternatives, including innovations.

PURPOSE

The purpose of this report is to make available to training specialists a procedure for choosing instructional delivery systems appropriate to various types of military training. The TECEP technique serves as a performance aid for the training specialist to use in defining appropriate training strategies for training objectives, choosing instructional delivery systems capable of carrying out the training strategies, and identifying the relative cost of these alternatives. Through the use of this procedure, training specialists choose the cost-effective instructional delivery system over its competitors.

ORGANIZATION OF THE REPORT

In addition to section I, two other major sections are presented. Section II provides an overview of the TECEP technique. The basic concepts and terms employed are defined. Section III provides reference

[2] Staff Study on Cost and Training Effectiveness of Proposed Training Systems, TAEG Report No. 1, 1972. Training Analysis and Evaluation Group, Orlando, Florida.

[3] Richard Braby, An Evaluation of Ten Techniques for Choosing Instructional Media, TAEG Report No. 8, December 1973. Training Analysis and Evaluation Group, Orlando, Florida.

materials used in choosing delivery systems. A formal three-step selection procedure is described and illustrated through the use of a sample problem.

Supporting information is presented in three appendices. Appendix A provides an alternate method for step 2 in the TECEP procedure, the selection of candidate instructional delivery systems. A wider range of solutions can be considered using the alternate procedure. Appendix B contains an analysis of the equations and economic theory in the cost model, and appendix C provides a Fortran IV program listing of the cost model.

A series of three reports contains the information needed to use the TECEP technique. In support of the material in this report are TAEG Report No. 23,[4] which provides the learning models used in selecting delivery systems, and TAEG Report No. 24,[5] which provides a detailed sample application of this technique.

[4] James A. Aagard and Richard Braby, Learning Guidelines and Algorithms for Twelve Types of Training Objectives, TAEG Report No. 23. Training Analysis and Evaluation Group, Orlando, Florida (manuscript form, to be published mid-1975).

[5] Richard Braby, Choosing Instructional Delivery Systems with the TECEP Technique - A Case Study, TAEG Report No. 24. Training Analysis and Evaluation Group, Orlando, Florida (manuscript form, to be published mid-1975).

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SECTION II

OVERVIEW OF THE TECEP TECHNIQUE

BACKGROUND

The TECEP is a technique for selecting cost-effective instructional delivery systems for proposed training programs. It provides an orderly approach to making delivery system choices during the conceptual design phase. A sequence of steps is provided for identifying generic types of delivery systems capable of accomplishing designated training objectives and for determining the costs of owning each of these types of training systems.

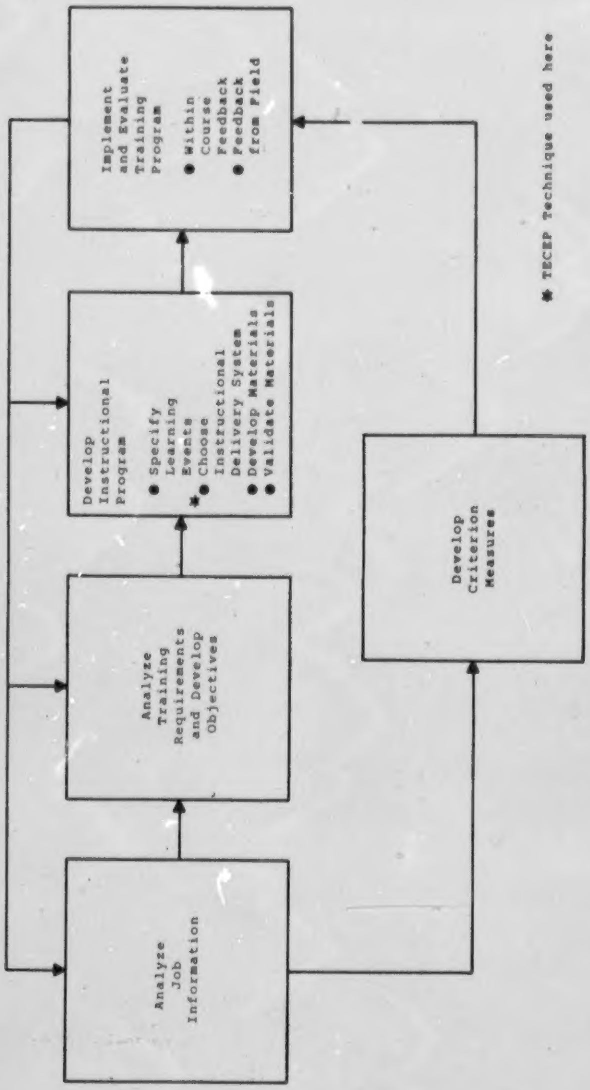
As defined in section I, an instructional delivery system is made up of the student and all of the elements with which he interacts to achieve the instructional goals. Included are the instructional media, both hardware and courseware, the instructor, other students in peer instruction, and the direct supporting services for equipment maintenance and courseware development. While media may be a prominent part of an instructional delivery system, the choice of a medium includes a package of all of the elements in the instructional delivery system. Therefore, the availability and effectiveness of each of the elements in the delivery system must be considered in making a media choice.

The TECEP technique requires user expertise. It is not a mechanical procedure. It requires the design team to make a series of key decisions which influence significantly the resultant media mix alternatives. The TECEP is best described as a job aid for an experienced training system designer. What it provides is a pathway and procedures for systematically coming to grips with critical issues in planning for cost-effective instruction.

Figure 1 shows the general sequence of the instructional system design process and identifies the chief function which can be performed using the TECEP technique.

TECEP LOGIC

The process of selecting instructional delivery systems is formally initiated when the training objectives for a proposed training system have been received. A set of training objectives are an input to the TECEP process. Starting with this set of objectives a sequence of steps is accomplished for deriving appropriate learning strategies, identifying instructional delivery systems capable of supporting these strategies, and determining costs associated with these delivery systems. The output of this effort is a description of an optimum instructional delivery system for accomplishing the training objectives. The TECEP process flow is shown in figure 2. Each of the elements in this process is described in subsequent paragraphs; the specific materials and guidelines for their use are provided in section III of this report.


Analyze Job Information
Analyze Training Requirements and Develop Objectives
Develop Instructional Program
● Specify Learning Events
*● Choose Instructional Delivery System
● Develop Materials
● Validate Materials
Implement and Evaluate Training Program
● Within Course Feedback
● Feedback from Field
Develop Criterion Measures

* TECEP Technique used here

Figure 1. Training System Development Model

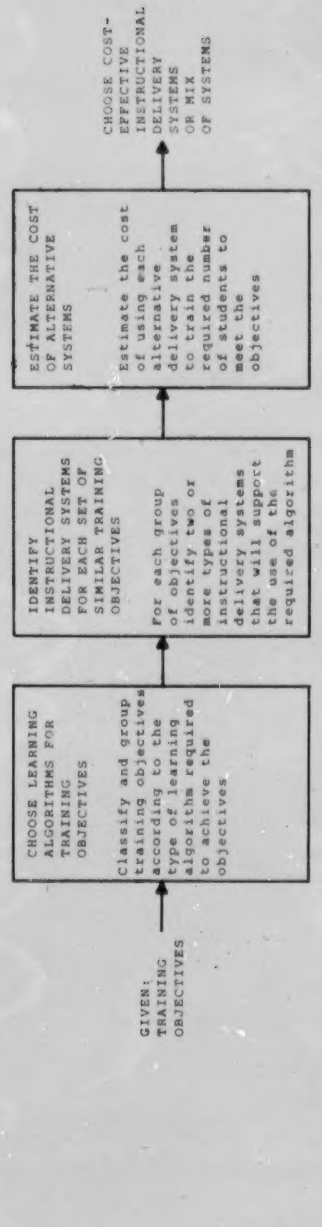

GIVEN: TRAINING OBJECTIVES
CHOOSE LEARNING ALGORITHMS FOR TRAINING OBJECTIVES
Classify and group training objectives according to the type of learning algorithm required to achieve the objectives
IDENTIFY INSTRUCTIONAL DELIVERY SYSTEMS FOR EACH SET OF SIMILAR TRAINING OBJECTIVES
For each group of objectives identify two or more types of instructional delivery systems that will support the use of the required algorithm
ESTIMATE THE COST OF ALTERNATIVE SYSTEMS
Estimate the cost of using each alternative delivery system to train the required number of students to meet the objectives
CHOOSE COST-EFFECTIVE INSTRUCTIONAL DELIVERY SYSTEMS OR MIX OF SYSTEMS

Figure 2. Process Flow in the TECEP Technique

CHOOSE LEARNING ALGORITHMS FOR TRAINING OBJECTIVES. An algorithm is "a precise, generally comprehensible prescription for carrying out a defined sequence of elementary operations in order to solve any problem belonging to a certain class."[6] Therefore, a learning algorithm is a step-by-step prescription for a student to follow in learning any specific task in a class of learning tasks, such as procedure following or decision making. It is a general sequence for use with all similar training objectives. Learning algorithms have been prepared for the more commonly experienced types of military training tasks. Within the TECEP approach, each training objective is matched with one of the learning algorithms.

IDENTIFY INSTRUCTIONAL DELIVERY SYSTEMS FOR EACH SET OF SIMILAR TRAINING OBJECTIVES. A student must be able to carry out each of the steps in the algorithm selected for a given set of objectives. An instructional delivery system is to be selected that enables this sequence of events to take place. The delivery system shall be capable of (1) displaying the essential stimulus characteristics of the subject matter; i.e., color, motion, sound; (2) allow the student to respond appropriately; i.e., choose an answer or manipulate a control; and (3) provide the student with the required form of feedback and reinforcement; i.e., his scores or a dynamic change in the performance of the system. All of these events are specified within the algorithms. In part, the TECEP technique serves as a performance aid for the training system designer to use in identifying all those delivery systems with the stimulus, response, and feedback capabilities required to carry out the events in the selected algorithm

ESTIMATE THE COST OF ALTERNATIVE SYSTEMS. The cost of using an instructional delivery system is the total value of all resources consumed in that part of the training program supported by the instructional delivery system. Included are the costs of the equipment, the curriculum materials, the personnel (e.g., instructors and support personnel), the supplies consumed, the facilities supporting the use of the system, and the wages and other costs of the student who learns from the system. These costs can be estimated with the aid of a formal cost model. This cost model is designed to display the cost implications of substituting one medium for another in a delivery system or for comparing entirely different instructional delivery systems.

CHOOSE COST-EFFECTIVE INSTRUCTIONAL DELIVERY SYSTEM OR MIX OF SYSTEMS. To be cost effective a delivery system must (1) facilitate student learning of the required behavior and (2) have a relatively low use cost when compared with other systems also able to support the required learning. Using the TECEP technique, a training system design team chooses an instructional delivery system based on estimated training effectiveness and cost. Solutions which minimize resource consumption while meeting training objectives become prime candidates for incorporation into the proposed training system.

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[6] N. Landa, Algorithmization in Learning and Instruction, Englewood Cliffs, N.J.: Educational Technology Publications, 1974, p. 11.

REQUIRED REFERENCE MATERIALS

Various types of reference materials pertinent to the TECEP process flow are described next. They serve as printed job aids to be used in carrying out each of the steps in the selection of a delivery system. Figure 3 identifies these aids, and an introductory description of each item is presented next. The actual reference materials and directions for their use are presented in section III.

TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT. Learning algorithms have been developed for fundamentally different types of training objectives representing military tasks. They are based, in part, on the Willis and Peterson[7] list of common Navy tasks and are designed so that (1) a wide range of tasks can be grouped into a small number of categories, (2) all the training objectives in one category can be achieved by using a single learning algorithm, and (3) each category of training objectives requires a different learning algorithm; i.e., fundamentally different from the training strategies required by other classes of training objectives.

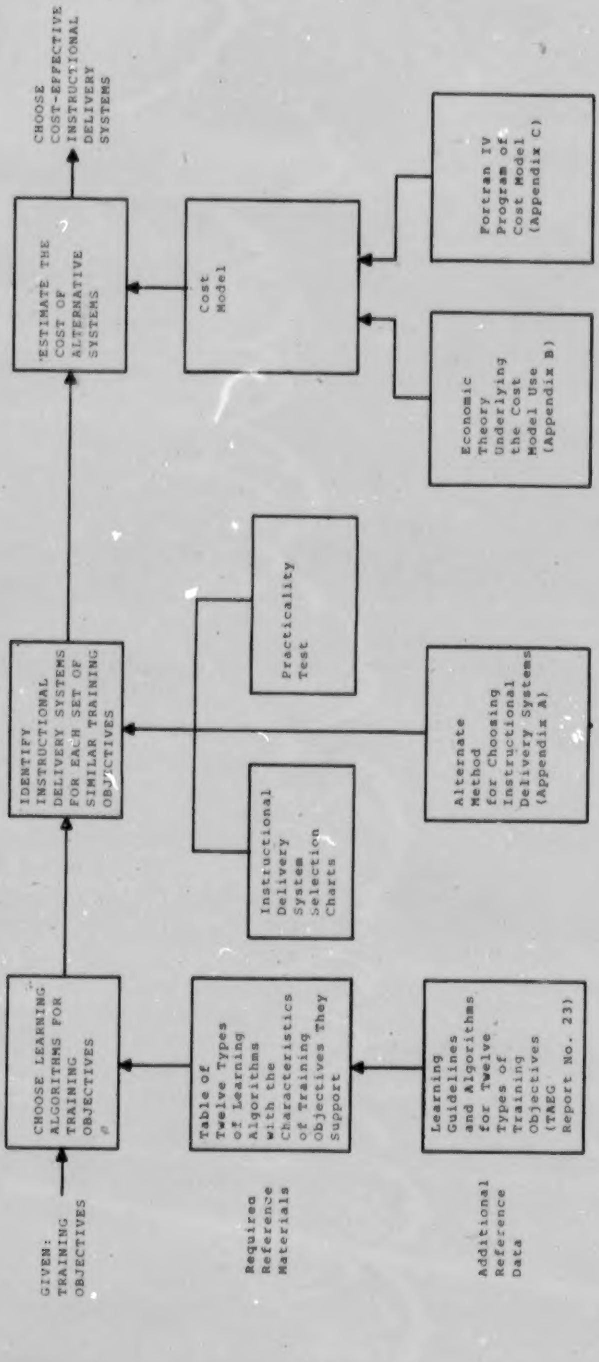
Only the names of the learning algorithms and the characteristics of the training objectives they support are included in this volume. The actual algorithms are presented in a companion volume, Learning Guidelines and Algorithms for Twelve Types of Training Objectives, TAEG Report 23, to be published mid-1975.

INSTRUCTIONAL DELIVERY SYSTEM SELECTION CHARTS. A table is presented for each of the 12 learning algorithms. Across the top of each is a comprehensive list of instructional delivery systems that generally can be used to carry out the steps in the algorithm. On the left side are listed special selection criteria. These criteria may include stimulus requirements and other training setting and administrative criteria unique to specific training programs. An "X" appears in those cells of the table where the instructional delivery system meets the special criteria.

By entering the table with those special criteria required by a training program, useful alternative delivery system approaches can be quickly identified.

---

[7] M. Paul Willis and Richard O. Peterson, Deriving Training Device Implications from Learning Theory Principles, Vols. I, II, and III, Technical Report: NAVTRADEVCEN 784-1. July 1961. U.S. Naval Training Device Center, Port Washington, NY.


GIVEN:
TRAINING
OBJECTIVES
CHOOSE LEARNING ALGORITHMS FOR TRAINING OBJECTIVES
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ESTIMATE THE COST OF ALTERNATIVE SYSTEMS
CHOOSE COST-EFFECTIVE INSTRUCTIONAL DELIVERY SYSTEMS
Required Reference Materials
Table of Twelve Types of Learning Algorithms with the Characteristics of Training Objectives They Support
Instructional Delivery System Selection Charts
Practicality Test
Cost Model
Additional Reference Data
Learning Guidelines and Algorithms for Twelve Types of Training Objectives (TAEG Report No. 23)
Alternate Method for Choosing Instructional Delivery Systems (Appendix A)
Economic Theory Underlying the Cost Model Use (Appendix B)
Fortran IV Program of Cost Model (Appendix C)

Figure 3. Reference Materials Supporting the TECEP Process Flow

TEST OF PRACTICALITY. Eleven criteria required for practical training system proposals are listed. Impractical solutions that do not meet these criteria are screened out.

COST MODEL. This model is a series of mathematical equations representing the cost of using instructional delivery approaches in a training system. It incorporates a list of cost factors to be considered and a procedure for combining these factors. The model includes the cost of acquiring and operating facilities and equipment, the cost of supplies, the cost of the design of instructional materials, the cost of support personnel, and student costs associated with the use of each specific instructional delivery system. By exercising the model for two or more alternatives, a comparison can be made of the costs of using different types of instructional delivery systems. The cost advantages or disadvantages of each system become apparent from the output of the model. The model has been designed to be responsive to the requirements for economic analysis as specified in DoD Directive 7041.3 and SECNAVINST 7000.14A.

ADDITIONAL SUPPORTING DATA

Figure 3 also provides additional data to aid the user in the practical application of the TECEP technique. Each type of data is described in subsequent paragraphs. The actual materials are located in the appendixes of this report and also in the companion reports mentioned earlier.

LEARNING GUIDELINES AND ALGORITHMS. The learning guidelines and algorithms described below are presented in a separate volume (TAEG Report No. 23) so that training system designers can more conveniently use these aids in a variety of steps in the instructional system development process. The separate volume can be used in choosing instructional events during the planning of a curriculum and in preparing storyboards and scripts during media development, as well as in selecting delivery systems.

Learning Guidelines. These guidelines are statements which prescribe specific characteristics to be built into the design of a training system. Guidelines are based in part on learning theory and in part on practical experience. They are prepared in groups to describe the major characteristics required in a training system to accomplish a given type of training task. Groups of learning guidelines have been developed for the 12 types of training objectives.

Learning Algorithms. A learning algorithm has been prepared to represent each of the 12 sets of learning guidelines. Each describes a sequence or pattern of events called for by the learning guidelines. Presented as flow diagrams, they indicate the data processing requirements for carrying out the intent of the learning guidelines.

Application of TECEP Technique. The guidelines and algorithms are presented as tentative statements and may vary in usefulness with the complexity of the training problems. While the sets of guidelines and algorithms display less than proven solutions to classes of training problems, they are thought to represent the best information available today for prescribing general solutions.

Accepting or rejecting an instructional delivery system is based on the criterion of whether it will support the use of the appropriate set of learning guidelines and related algorithm. It must be feasible to carry out all operations of the algorithm within the proposed delivery system for the system to be identified as a useful alternative. While the Instructional Delivery System Selection Charts contain alternatives that meet this criterion, the designer may wish to perform his own analysis, or to consider a media-mix not presented on a chart. The guidelines and algorithms, therefore, are available to support this function if he chooses to use them. Familiarity with these guidelines and algorithms is essential to an understanding of the TECEP technique.

ALTERNATE METHOD FOR CHOOSING INSTRUCTIONAL DELIVERY SYSTEMS. A method is provided for the designer to consider delivery systems not included in the formal Instructional Delivery System Solution Charts. With this method, generic media characteristics required to implement the learning algorithms are stated, and media containing these characterists are identified.

To support the designer in applying this method, two performance aids are provided. The first is a list of generic media characteristics. This refers to fundamental or basic capabilities found in the structure of many types of instructional media. Fifty-five generic media characteristics have been identified. The list includes stimulus characteristics such as "sound" and "color," trainee response modes including "multiple choice" and "tracking," and performance feedback characteristics that can be used as standard media descriptors in defining existing types of instructional media. They can also be used in prescribing the general characteristics required of a medium for a proposed instructional delivery system, thus aiding the designer in choosing types of media that contain all the required characteristics.

The second aid is called a media pool. It is a list of 89 general types of instructional media that can be incorporated into instructional delivery systems. Each is defined and described. Included are media of various levels of development: operational forms of instructional material such a programmed texts and motion pictures, forms under development such as various types of computer-assisted instruction and computer simulation games, and media concepts that have not yet reached the prototype or pilot project stages such as video disc and microform with information mapping. The list includes a broad range of media types, from printed and recorded media such as motion pictures and broadcast television to three-dimensional "hands-on" media such as mock-ups and simulators.

COST MODEL: DISCUSSION, ASSUMPTIONS AND LIMITATIONS. Background data on the cost model including economic concepts and equations that make up the cost model are presented, and all terms are defined. An understanding of these economic concepts and equations will aid the designer in assigning values to the variables in the cost model and in interpreting the output of the model. Limitations of the model are described to aid the analyst in avoiding certain pitfalls in interpreting the cost model output data.

FORTRAN PROGRAM OF COST MODEL. Manual use of the cost model involving hand calculation is a tedious undertaking. To aid training system designers in the use of the cost model, a program listing of a FORTRAN IV program of the cost model is provided, with a sample of the input data. Instructions for the use of the program are included.

POST NOTE

Potential users of the TECEP technique should be aware of limitations of the technique. It deals with highly simplified descriptions of proposed training systems. The TECEP technique is used as a performance aid in conducting trade-off studies of alternatives prior to the detailed development of any one of the alternatives. Only the major parameters of these systems are considered.

In addition, certain terms used in the equations must be assigned estimated values due to the absence of available quantitative data. Also, subjective interpretations are made at certain key points in the process. Thus, user expertise is required.

The technique encourages the consideration of unorthodox training solutions in that a wide range of alternative media are examined prior to final solution. Therefore, the TECEP technique is not appropriate in design situations where instructional delivery system choices are constrained or where operational practices or policies rule out many pertinent forms of media.

The learning algorithms in the technique represent training approaches for most of the important types of Navy training tasks. No claim is made that all types of Navy training are included. There will be instances where a new training requirement may fall outside the list of training objective classes considered in this technique, or where it might be represented only by a complex mix of these categories and, therefore, be difficult to align with a specific learning algorithm. The learning guidelines and algorithms are less than final and in actual use must be adjusted to accommodate specific situations. The media classes do not discriminate between the extensive variations that exist within many of the classes. In certain instances, therefore, following the detailed TECEP procedures will not be productive, but the use of the media list, the cost model, and other parts of the procedure may still be useful.

The procedure and the guidelines presented in section III must be used with these cautions in mind. The technique is not inviolate, and the quality of the output will be dependent on the expertise of the designers.

SECTION III

THE TECEP TECHNIQUE

The TECEP technique for choosing cost-effective instructional delivery systems can be used as a detailed step-by-step procedure or it can be used generally, in a less structured manner, as background information in making delivery system choices.

The technique consists of three steps as shown in table 1. Each step is described in detail with appropriate guidelines in this section. For ease of usage, each step is presented on a separate page, followed by an example of the step. Reference tables (2 through 14) required to carry out these steps have been placed in the back of this section. Tabs have been placed on each of the frequently used references to aid the designers in the repeated use of these materials.

TABLE 1. STEPS IN THE TECEP TECHNIQUE

GIVEN:	Training Objectives for a Course of Instruction
Step 1	Classify and group training objectives according to the type of learning algorithm required to accomplish the objectives.
Step 2	For each group of objectives, identify two or more types of instructional delivery systems that will support the use of the required algorithm.
Step 3	Estimate the cost of using each alternative delivery system to train the required number of students to meet the objectives.
Then:	Choose the cost-effective instructional delivery system, or mix of systems.

Step 1. Classify and group training objectives according to the type of learning algorithm required to accomplish the objectives. The initial step is to match each training objective in the proposed training system with the name of the learning algorithm appropriate for achieving the objective. The names of 12 learning algorithms and the characteristics of training objectives that can be accomplished with these algorithms are listed in table 2. A tentative classification of a training objective is accomplished by merely matching the objective with the name of one of the learning algorithms. This classification can be verified by comparing the characteristics of the training objective with the action verbs, behavioral attributes, and examples of objectives that can be achieved with that type of algorithm, as listed in table 2. Use only the predominant or critical characteristics of the training objective in making this determination. If two or more algorithms appear to be required for a training objective, consider dividing the objective into two or more simpler objectives which can each be accomplished with a single algorithm. Group the training objectives into sets that are classified alike.

The reader may wish to review TAEG Report No. 23[8] for background information on the learning algorithms and the learning guidelines upon which they are based.

An example of this step demonstrates the procedure:

Training Objective. Given (1) an operational RF signal generator, Hewlett Packard 614A, (2) the characteristics of the signal to be generated, and (3) an operator's checklist, the trainee will operate the equipment; i.e., he will describe and then perform each step in the equipment turn-on and set-up procedure, proceeding through the checklist without error.

This training objective has been matched with learning algorithm Number 9, Recalling Procedures, Positioning Movement. This match is appropriate in that the characteristics of the training objective are similar to two of the examples, all the behavioral attributes, and one of the action verbs listed for this type of learning algorithm, as shown by the checks in figure 4.

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[8] J. A. Aagard and R. Braby, Learning Guidelines and Algorithms for Twelve Types of Training Objectives, TAEG Report No. 23. Training Analysis and Evaluation Group, Orlando, Florida (manuscript form, to be published mid-1975).

	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
NAMES OF LEARNING ALGORITHMS	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
9. RECALLING PROCEDURES, POSITIONING MOVEMENT	Activate Adjust Align Assemble Calibrate Disassemble Inspect ✓Operate Service	✓1. Concerns the chaining or sequencing of events. ✓2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. ✓3. Procedural check lists are frequently used as job aids.	1. Recalling equipment assembly and disassembly procedures. ✓2. Recalling the operation and check-out procedures for a piece of equipment (cockpit check lists). ✓3. Following equipment turn-on procedures - emphasis on motor behavior.

Figure 4. Sample of Matching Training Objective Characteristics with a Type of Learning Algorithm

RECALLING PROCEDURES AND POSITIONING MOVEMENT

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems											
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm								Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorit			
		Operational System in Laboratory with Tutor	Simulator with Tutor and Tests	Procedures Trainer with Tutor and Tests	Logic Trainer with Tutor	CAI with Photo or Operable Mockup	Teaching Machine with Photo or Operable Mockup	Microfiche w/wo Photo or Operable Mockup	Programmed Text - Branching	Laboratory Carrel with Equipment and Linear Instructional Materials	Operational System in Real Environment with Tutor	Texts, Lectures and Demonstrations	
Complexity Criteria													
● Difficult Motor Acts		X	X	X	X					X	X		
● Smooth Motor Performance at End of Training		X	X	X						X	X		
Stimulus Criteria													
● Visual Form													
Alpha-Numeric	✓	X	X	X	X	X	X	X	X	X		X	
Pictorial, Plane					X	X	X	X	X	X		X	
Object, Solid	✓	X	X	X	X					X	X	X	
● Visual Movement													
Still					X	X	X	X	X	X		X	
Full Movement		X	X	X	X	X				X	X		
● Audio													
Voice Sound Range		X	X	X		X				X	X	X	
Full Sound Range		X	X	X						X	X		
Ambient Sounds		X	X	X							X		
● Other													
Tactile Cues		X	X	X						X	X		
Internal Stimulus Motion Cues		X	X	X						X	X		
Training Setting Criteria													
● Individual Trainee at Fixed Location	✓	X	X	X	X	X	X	X	X	X	X	X	
● Individual Trainee with Independent Instruction at Any Location								X	X				
● Small Group					X							X	
● Large Group at Single Location												X	
● Team Setting		X	X	X	X						X		
Administrative Criteria													
● Site of Courseware and Special Hardware Development													
Local								X	X	X	X	X	
Central	✓	X	X	X	X	X	X	X	X	X	X		
● Magnitude of Acquisition Cost													
Low	✓							X	X	X		X	
High		X	X	X	X	X	X			X	X		

Figure 5. Sample of Delivery System Selection

Step 2. For each group of objectives, identify two or more types of instructional delivery systems which will support the use of the required algorithm. Use the Instructional Delivery System Selection Charts, tables 3 through 14, to perform the first part of this Step in the procedure. First, locate the chart representing the algorithm selected in Step 1. The chart for the algorithm, Recalling Procedures and Positioning Movement, required in the sample problem is provided as figure 5. Note that the columns headed Alternative Instructional Delivery Systems are divided into two sections; i.e., those permitting the full use of the algorithm and those not permitting full use. The latter group includes some existing or traditional practices that are considered to be less powerful or efficient than those enabling the full use of the algorithm. The designer may wish to add additional approaches to either side of the chart.

Along the left side of the chart special criteria are listed for selecting from the delivery systems presented across the top of the chart. While a large number of criteria had to be satisfied during the development of the chart, only those unique to specific applications need be considered by the designer. Those criteria presented generally concern the stimulus demands of the subject matter, requirements of the training setting, and certain administrative and budgetary constraints unique to the specific instructional program.

A blank column, with the heading "Directions" appears on the chart immediately to the right of the criteria list. To use the chart, place a light check in pencil in those cells designating criteria that must be satisfied by the delivery system. Then determine which delivery systems meet all these special criteria.

This part of the procedure for Step 2 has been carried out in figure 5. Note the criteria that were checked as being essential to the training program for this objective. Also note that only the circled delivery systems met all the special criteria. Two permit the full algorithm to be used, and one does not support the full use of the algorithm. The two tentatively recommended alternatives are:

1. Operational System in a Laboratory with Tutor
2. Microfiche with or without Photo or Operable Mock-up.

Test of Practicality. Each candidate delivery system should be critically evaluated in terms of the following criteria to insure that each is a practical solution to the training problem. Reject those alternatives that are impractical.

1. Marginal Technical Solutions -- The learning guidelines and algorithm cannot be easily carried out with the system.

2. State-of-the-Art -- The system is under development or test and may not be available for practical application by the time it is required.

3. Size of System -- Some approaches are useful within large training programs. Others are suited only for small programs and, therefore, may not be suited to the size program being considered.

4. Interface with Existing Program -- Many new courses must be designed to fit into existing programs, which place constraints on the new courses; e.g., equipment on hand, available classrooms, scheduling practices.

5. Time to Produce System -- Approaches which require long lead times for development may not be useful when scheduled ready-for-training dates do not allow a long development cycle.

6. Budget Cycle Constraints -- While the application of some of the powerful training approaches, such as CAI (Computer Assisted Instruction), may result in low costs per student graduate, the initial investment is substantial. Unless these resources appear in existing budgets, the applications of these techniques to an immediate problem may not be feasible.

7. Adoption of Innovations -- Instructors frequently resist innovations. If the proposed technique is significantly different from existing techniques, either adequate resources must be focused upon gaining acceptance for the innovation, or a more traditional approach must be selected.

8. Courseware Development -- If the courseware is to be locally developed, skilled personnel, equipment, time, and dollars must be made available.

9. High Cost Alternatives -- The projected life cycle cost of a media approach may be significantly higher than other equally useful alternatives. Reject high cost alternatives when others are available.

10. Learning Style of Trainees -- If the trainee has a low reading ability or would be limited in his ability to use certain kinds of systems then reject these systems as inappropriate.

11. Other Constraints -- A variety of other practical factors should be considered; e.g., command policy and existing investment in production facilities.

In the case of the sample problem, the approach requiring the use of operational equipment with a tutor is found to be a practical solution. No problems were identified by considering each criterion in the practicality test. During consideration of the microfiche-based approach, however, a low degree of risk was identified for two items. The first low risk area concerned test item Number 2, the "state-of-the-art." Studies involving the use of color microfiche in procedure-following training have not been conducted within the Department of Defense. However, applications in industry have been successful. Some risk, however, is associated with the initial applications of colored microfiche in the military environment. The second low risk area concerned test item Number 8, "courseware development." It is assumed that the team developing the courseware will have no experience in developing microfiche-based courseware. This lack of experience is not considered to be a serious problem. Skills required would be similar to those used in writing programmed texts and making slide sets. The reproduction of the color microfiche would be accomplished by a commercial laboratory.

Both instructional delivery systems survived the practicality test and are considered to be candidates for use in the proposed training system.

An alternative approach to Step 2 is presented in appendix A. This approach allows the training system design team to consider solutions not contained in the Instructional Delivery System Selection Charts. It is intended for use by those with an expert knowledge of media.

Step 3. Estimate the cost of using each alternative delivery system to train the required number of students to meet the objectives. Use the Cost Data Collection Form, included as Attachment 1 at the end of this report, to record the data necessary to run the cost model for a single alternative. Repeat this process for each of the alternative instructional delivery systems. Figure 6 presents the cost data in the two instructional delivery systems in the sample problem. The values assigned to each of the input variables are dictated by the problem under analysis. It is, therefore, the responsibility of the training specialist to develop these values for his problem. Much of the necessary data can be developed from historical information, manuals, and other secondary sources. Where no empirical data exists, it may be necessary to make estimates for selected variables. These data must be in accordance with the definitions shown in appendix B and coded in the format specified in appendix C. The coded data along with the working computer program in Fortran IV in appendix C can be delivered to almost any data processing group for processing. Although the computations can be performed on a hand calculator, this is a time-consuming process. Most tasks require numerous runs of the program which would require an unacceptable number of man-hours for manual computation.

The output of this procedure is a numerical value for 31 factors which describe various aspects of the cost of using a training system. One output of the model is the "present cost" of each alternative instructional delivery system. The "present cost" represents the amount of money that would be necessary at the beginning of the project to implement and operate the project over the entire planned life of the system. The amount of money held for use during the second and subsequent years is credited with interest at a specified rate. The costs for each year in the planning period are discounted to reflect this time value of money and these discounted costs are summed to obtain the "present cost" of the alternative. The justification for discounting evolves from the concept that expenditures which are postponed to future years cost less in terms of today's dollars than tomorrow's dollars. With this type of cost information, alternative training systems can be compared and the systems ranked in terms of their cost. The cost advantages or disadvantages inherent in choosing one system over another become apparent.

Cost summary data for the sample problem generated through the use of the cost model are contained in figure 7. Data for the two candidate systems are presented next to each other so that comparisons can be easily made. Intermediate output data on each of these alternatives are presented in appendix C. Cost analysis ends when system costs have been projected for each of the proposed alternative training systems.

Instructional Delivery System Operational System in a Laboratory With Tutor

Run ID Example 1

FORTRAN Symbol	Variable Description	VALUE	Units
Facilities			
FACOST	Total facilities acquisition and/or refurbishing costs	0	Dollars
LOFFA	Expected years of life of FACOST assets (in whole numbers)	0	Years
SQFTIN	Total square feet required for each instructor	64	Sq ft
SQFTST	Total square feet required per student position	75	Sq ft
SQFTAM	Total square feet required for administrative overhead for all student positions	100	Sq ft
Equipment			
EQCISP	Equip. implementation costs independent of stud. pos.	0	Dollars
LOFEQ1	Expected years of life of EQCISP assets (in whole numbers)	0	Years
EQIMPC	Equip. implementation costs per student position	3000	Dollars
LOFEQ	Expected years of life of EQIMPC assets	10	Years
TSPOSD	Percent of operating time student position down	0.01	Percent

Figure 6. Sample Cost Data on Cost Data Collection Form

FORTRAN Symbol	Variable Description	Value	Units
Instructional Material (IM)			
UIMD	% of TLENGH (i.e., time spent in training medium) for which new instructional material must be developed	1.00	Percent
UPDATE	% of original development cost required each year to maintain instructional material	0.30	Percent
EVIM	% of original development cost remaining at end of planning period	0	Percent
CIMD	Average cost of developing one hour of instructional material	50	Dollars
Personnel			
INTSPO	Instructor to student position ratio	1.0	Decimal Ratio
SALINR	Annual salary and benefits of one instructor	16,240	Dollars
Supplies			
SUPPLY	Cost of expendable supplies for each student while enrolled in course	0	Dollars
Students			
STUDSL	Annual salary and benefits of one student	11,141	Dollars
STCST1	Average student travel cost to and from school	0	Dollars
STCST2	Average per student travel cost as a part of course	0	Dollars
Miscellaneous			
N	Number of years in planning period	10	Years
ARATE	Attrition rate	0.04	Percent
DRATE	Discount rate	0.10	Percent
WSCHOP	Weeks school operates each year	50	Weeks
TLENGH	Average time spent in training medium per student (non-recycled students)	0.1	Weeks
TLEGTH	Average hours per week student spends in medium	3	Hours
RCRATE	Recycle rate	0	Percent
ARCYTM	Average time the recycled student spends repeating material	0	Weeks
ESP	Percentage of excess student positions required to provide for fluctuations in input	0.05	Percent

NOTE: All percent values are entered as decimal equivalents.

Figure 6. Sample Cost Data on Cost Data Collection Form (continued)

FORTRAN SYMBOL	VARIABLE	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10
		YR 11	YR 12	YR 13	YR 14	YR 15	YR 16	YR 17	YR 18	YR 19	YR 20
Facilities											
CPSQFT(I)	Cost/Ft^2 for Facilities Per Year (Dollars)	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Equipment											
CAQSP(I)	Equipment Acquisition Cost/Student Position	0	0	0	0	0	0	0	0	0	0
LOFEQ(I)	Expected Life of CAQSP(I) Assets (Years)	0	0	0	0	0	0	0	0	0	0
COPMT(I)	Operation and Maint. Cost of Equipment Per Student Position for Each Year (Dollars)	150	150	150	150	150	150	150	150	150	150
OMFEQ(I)	O & M Costs of Fixed Equipment (Dollars)	0	0	0	0	0	0	0	0	0	0
Students											
UIMDYR(I)	Unique Hours of IMD Per Year (Hours)	0	0	0	0	0	0	0	0	0	0
Instructional Material											
GRAD(I)	No. of Graduates Required for Each Year (Number)	1300	1400	1300	1200	1200	1100	1100	1100	1150	1100

Figure 6. Sample Cost Data on Cost Data Collection Form (continued)

Instructional Delivery System Microfiche with Photo Mockup

Run ID Example 2

FORTRAN Symbol	Variable Description	Value	Units
Facilities			
FACOST	Total facilities acquisition and/or refurbishing costs	0	Dollars
LOFFA	Expected years of life of FACOST assets (in whole numbers)	0	Years
SQFTIN	Total square feet required for each instructor	64	Sq ft
SQFTST	Total square feet required per student position	75	Sq ft
SQFTAM	Total square feet required for administrative overhead for all student positions	100	Sq ft
Equipment			
EQCISP	Equip. implementation costs independent of stud. pos.	0	Dollars
LOFEQ1	Expected years of life of EQCISP assets	0	Years
EQIMPC	Equip. implementation costs per student position	275	Dollars
LOFEQ	Expected years of life of EQIMPC assets (in whole numbers)	10	Years
TSPOSD	Percent of operating time student position down	0.01	Percent

Figure 6. Sample Cost Data on Cost Data Collection Form

FORTRAN Symbol	Variable Description	Value	Units
Instructional Material (IM)			
UIMD	% of TLENGH (i.e., time spent in training medium) for which new instructional material must be developed	1.00	Percent
UPDATE	% of original development cost required each year to maintain instructional material	0.20	Percent
EVIM	% of original development cost remaining at end of planning period	0	Percent
CIMD	Average cost of developing one hour of instructional material	1134	Dollars
Personnel			
INTSPO	Instructor to student position ratio	0.1	Decimal Ratio
SALINR	Annual salary and benefits of one instructor	16,240	Dollars
Supplies			
SUPPLY	Cost of expendable supplies for each student while enrolled in course	0	Dollars
Students			
STUDSL	Annual salary and benefits of one student	11,141	Dollars
STCST1	Average student travel cost to and from school	0	Dollars
STCST2	Average per student travel cost as a part of course	0	Dollars
Miscellaneous			
N	Number of years in planning period	10	Years
ARATE	Attrition rate	0.04	Percent
DRATE	Discount rate	0.10	Percent
WSCHOP	Weeks school operates each year	50	Weeks
TLENGH	Average time spent in training medium per student (non-recycled students)	0.1	Weeks
TLEGTH	Average hours per week student spends in medium	4	Hours
RCRATE	Recycle rate	.05	Percent
ARCYTM	Average time the recycled student spends repeating material	0.1	Weeks
ESP	Percentage of excess student positions required to provide for fluctuations in input	0.05	Percent

NOTE: All percent values are entered as decimal equivalents.

Figure 6. Sample Cost Data on Cost Data Collection Form (continued)

FORTRAN SYMBOL	VARIABLE	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10
		YR 11	YR 12	YR 13	YR 14	YR 15	YR 16	YR 17	YR 18	YR 19	YR 20
Facilities											
CPSQFT(I)	Cost/Ft^2 for Facilities Per Year (Dollars)	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Equipment											
CAQSP(I)	Equipment Acquisition Cost/Student Position	0	0	0	0	0	0	0	0	0	0
LOFEQ(I)	Expected Life of CAQSP(I) Assets (Years)	0	0	0	0	0	0	0	0	0	0
COPMT(I)	Operation and Maint. Cost of Equipment Per Student Position for Each Year (Dollars)	15	15	15	15	15	15	15	15	15	15
OMFEQ(I)	O & M Costs of Fixed Equipment (Dollars)	0	0	0	0	0	0	0	0	0	0
Students											
UIMDYR(I)	Unique Hours of IMD Per Year (Hours)	0	0	0	0	0	0	0	0	0	0
Instructional Material											
GRAD(I)	No. of Graduates Required for Each Year (Number)	1.300	1400	1200	1200	1200	1100	1100	1103	1100	1100

Figure 6. Sample Cost Data on Cost Data Collection Form (continued)

	PRESENT COST	AVERAGE DISCOUNTED COST PER GRADUATE	UNIFORM ANNUAL COST	ACQUISTION COST FOR FACILITIES ,EQUIP. AND INSTRUCTIONAL MATERIAL DEVELOPEMENT
SYSTEM A OPERATIONAL SYSTEM IN A LABORATORY WITH TUTOR	459902.6	38.4	71282.6	7739.5
SYSTEM B MICROFICHE WITH PHOTO MOCKUP	216395.2	18.7	33540.2	1198.4

	NO. OF INSTRUCTORS (IN MAN-YEARS PER YEAR)	NON-DISCOUNTED ANNUAL INSTRUCTOR COST	NO. OF STUDENT POSITIONS REQUIRED	AVERAGE HOURS PER GRADUATE IN MODULE
SYSTEM A OPERATIONAL SYSTEM IN A LABORATORY WITH TUTOR	2.6	41847.7	2.5	3.0
SYSTEM B MICROFICHE WITH PHOTO MOCKUP	0.3	4398.3	2.6	4.0

Figure 7. Sample of Summary Cost Data for Two Delivery System

Choose the Cost-Effective Instructional Delivery System or the Mix of Systems. The selection of one or a mix of the alternative instructional delivery systems and the justification of this choice is based on data organized in all three previous steps of the TECEP process. This final act of choosing a delivery system, however, cannot be proceduralized. While the low cost solution should be considered a prime candidate, the training system designer must still weigh the variations in cost among the useful delivery approaches, along with the relevant administrative factors that influence the selection of a delivery system irrespective of technical solutions.

Figure 8 provides a sample of this final act of the selection process.

Analysis of Delivery Systems for Operator Training on the Hewlett Packard 614A, RF Signal Generator

TRAINING TASK:	Given: (1) an operational RF signal generator, Hewlett Packard 614A, (2) the characteristics of the signals to be generated, and (3) the operator's checklist, the trainee will operate the equipment; i.e., he will describe and then perform each step in the equipment turn-on and set-up procedure, proceeding through the checklist without error.
TRAINING SETTING:	Using an appropriate instructional module, the school must train an average of 1190 students per year for approximately 10 years. These students will use the RF signal generator in laboratory exercises immediately following the completion of this module as well as at their duty station at the completion of the course. The school house will be open for student use 8 hours per day, 5 days per week, 50 weeks per year. The school uses individualized instruction, criterion performance measurement techniques, accepts students at any time, and allows students to leave the program as soon as they achieve criterion performance. A fairly even flow of students has been programmed through the training.
ALTERNATIVE INSTRUCTIONAL DELIVERY SYSTEMS:	System A: The student uses an operational unit of the Hewlett Packard 614A RF Signal Generator with a tutor as an instructor and evaluator. The instruction is performed in a laboratory setting. System B: The student uses a microfiche-based self-instruction system with a photo mock-up of the Hewlett Packard 614A RF Signal Generator. This self-instruction is performed in a carrel. An instructor serves as an evaluator.
ANALYSIS:	The training objective can be achieved using either system. Both are individualized approaches to instruction and therefore will fit into the individualized structure of the school. The significant differences between the two approaches are summarized in the following chart:

Figure 8. Sample Report on the Analysis of Proposed Instructional Delivery Systems

	Present Cost	Average Discounted Cost Per Graduate	Uniform Annual Cost	Acquisition Cost for Facilities, Equipment and Instructional Material Development
System A Operational System with Tutor	$460K	$39	$71K	$7.7K
System B Microfiche with Photo Mock-up	$216K	$18	$34K	$1.2K

	No. of Instructors (in man-years per year)	Non-Discounted Annual Instructor Cost	No. of Student Positions Required	Average Hours Per Graduate In Module
System A Operational System with Tutor	2.6	$42K	2.5	3
System B Microfiche with Photo Mock-up	.3	$4K	2.6	4

NOTE: The summary data in this figure appears also in figure 7.

Figure 8. Sample Report on the Analysis of Proposed Instructional Delivery Systems (continued)

All economic indicators point to System A being significantly more expensive than System B. The three overall cost indicators, the present cost, average discounted cost per graduate, and the uniform annual cost, all indicate that System A will be more than twice the cost of System B. Also, the initial acquisition cost of System A is over seven times the acquisition cost of System B. Instructor support is about 10 times more costly for System A than for System B.

The number of student positions required is essentially the same even though System B may require one-third more student man-hours than System A. The apparent increase in efficiency of System A is lost in that only two students a day would normally be scheduled into each student position. Tutoring requires almost 10 times more instructor man-hours than using an instructor only for evaluation.

The use of System B, the microfiche-based approach, involves a higher level of risk than does the use of System A. Tutoring is the traditional solution, and a microfiche-based self-study approach is an innovative approach with a limited number of instances of actual use. However, the significance of the risk with System B is low in that the cost of trying the microfiche approach with this module is low, both in dollars and man-hours. While microfiche are not presently being used to learn the operating procedures for signal generators, the technique is being successfully employed in learning the checkout and operating procedures for other electromechanical devices.

RECOMMENDATION: Use System B, the microfiche-based system with a photo mock-up. The potential dollar savings inherent in this approach, when compared with the other alternative, provides an adequate basis for accepting the low level risk involved in attempting to use the innovative microfiche approach.

Figure 8. Sample Report on the Analysis of Proposed Instructional Delivery Systems (continued)

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TABLE 2

TWELVE TYPES OF ALGORITHMS

TABLE 2. TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
1. RECALLING BODIES OF KNOWLEDGE	Answer Define Express Inform Select	1. Concerns verbal or symbolic learning. 2. Concerns acquisition and long-term maintenance of knowledge so that it can be recalled.	1. Recalling equipment nomenclature or functions. 2. Recalling system functions, such as the complex relations between system input and output. 3. Recalling physical laws, such as Ohm's law. 4. Recalling specific radio frequencies and other discrete facts.
2. USING VERBAL INFORMATION	Apply Arrange Choose Compare Determine	1. Concerns the practical application of information. 2. Generally follows the initial learning of information through the use of the guidelines for Recalling Bodies of Knowledge. 3. Limited uncertainty of outcome. 4. Usually little thought of other alternatives.	1. Based on academic knowledge, determine which equipment to use for a specific real world task. 2. Based on an academic knowledge of the system, compare alternative modes of operation of a piece of equipment and determine the appropriate mode for a specific real world situation. 3. Based on memorized knowledge of radio frequencies, choose the correct frequency in a specific real world situation.
3. RULE LEARNING AND USING	Choose Conclude Deduce Predict Propose Select Specify	1. Choosing a course of action based on applying known rules. 2. Frequently involves "If...Then" situations. 3. The rules are not questioned, the decision focuses on whether the correct rule is being applied.	1. Apply the "rules of the road." 2. Solve mathematical equations (both choosing correct equation and the mechanics of solving the equation). 3. Carrying out military protocol. 4. Selection of proper fire extinguisher for different type fires. 5. Using correct grammar in novel situations, covered by rules.
4. MAKING DECISIONS	Choose Design Diagnose Develop Evaluate Forecast Formulate Organize Select	1. Choosing a course of action when alternatives are unspecified or unknown. 2. A successful course of action is not readily apparent. 3. The penalties for unsuccessful courses of action are not readily apparent. 4. The relative value of possible decisions must be considered - including possible trade-offs. 5. Frequently involves forced decisions made in a short period of time with soft information.	1. Choosing frequencies to search in an ECM search plan. 2. Choosing torpedo settings during a torpedo attack. 3. Threat evaluation and weapon assignment. 4. Choice of tactics in combat - wide range of options. 5. Choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment. 6. Choosing to abort or commit oneself to land upon reaching the critical point in the glidepath.

TABLE 2. TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
5. DETECTING	Detect Distinguish Monitor	1. Vigilance - detect a few cues embedded in a large block of time. 2. Low threshold cues; signal to noise ratio may be very low; early awareness of small cues. 3. Scan for a wide range of cues for a given "target" and for different types of "targets."	1. Early sonar detection of a submarine target. 2. Visually detecting the periscope of a snorkeling submarine during daytime operations in a sea state of three. 3. Detect, through a slight change in sound, a bearing starting to burn out in a power generator.
6. CLASSIFYING	Identify Recognize Differentiate Classify	1. Pattern recognition approach of identification - not problem solving. 2. Classification by nonverbal characteristics. 3. Status determination - ready to start. 4. Object to be classified can be viewed from many perspectives or in many forms.	1. Classify a sonar target as "sub" or "non-sub." 2. Visual classification of flying aircraft as "friend" or "enemy" or as an "F-4." 3. Determining that an identified noise is a wheel bearing failure, not a water pump failure by rating the quality of the noise - not by the problem solving approach.
7. IDENTIFYING SYMBOLS	Identify Read Transcribe	1. Involves the recognition of symbols. 2. Symbols to be identified typically are of low meaningfulness to untrained persons. 3. Identification, not interpretation, is emphasized. 4. Involves storing queues of symbolic information and related meanings.	1. Reading electronic symbols on a schematic drawing. 2. Identifying map symbols. 3. Reading and transcribing symbols on a tactical status board. 4. Identifying symbols on a weather map.
8. VOICE COMMUNICATING	Advise Answer Communicate Converse Direct Express Instruct Interview Listed Order Report Speak	1. Speaking and listening in specialized languages. 2. Often involves the use of a specific message model. Standard vocabulary and format. 3. Also concerns clarity of voice, enunciation, speed. 4. Timing of verbalization is usually critical - when to pass information. 5. Typically characterized by redundancy in terms of information content. 6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns. **7. Task may be difficult due to presence of background noise.**	1. Officer giving oral orders and receiving reports. 2. Sonar operator passing oral information over communication net. 3. Instructions by GCA operator to pilot in landing aircraft.

TABLE 2. TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
9. RECALLING PROCEDURES, POSITIONING MOVEMENT	Activate Adjust Align Assemble Calibrate Disassemble Inspect Operate Service	1. Concerns the chaining or sequencing of events. 2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. 3. Procedural check lists are frequently used as jpb aids.	1. Recalling equipment assembly and disassembly procedures. 2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists). 3. Following equipment turn-on procedures - emphasis on motor behavior.
10. STEERING AND GUIDING - CONTINUOUS MOVEMENT	Control Guide Maneuver Regulate Steer Track	1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc. 2. Compensatory movements based on feedback from displays. 3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol. 4. Involves estimating changes in positions, velocities, accelerations, etc. 5. Involves knowledge of display-control relationships.	1. Submarine bow and stern plane operators maintaining a constant course, or making changes in course or depth. 2. Tank driver following a road. 3. Sonar operator keeping the cursor on a sonar target. 4. Air-to-air gunnery - target tracking. 5. Aircraft piloting such as: visually following a ground path. 6. Helmsman holding a course with gyro or magnetic compass.
11. PERFORMING GROSS MOTOR SKILLS	Cut Draft Draw March Mix Run Sew Sharpen Splice Swim Weld Write	1. Perceptual-motor behavior-emphasis on motor. Premium on manual dexterity, occasionally strength and endurance. 2. Repetitive mechanical skill. 3. Standardized behavior, little room for variation or innovation. 4. Automatic behavior - low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior. 5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate. 6. Fine tolerances. 7. Often a component of a larger task.	1. Use of hand tools such as hammer, saw, wrench, or power tools such as lathes or grinders. 2. Running a drill press in an assembly line. 3. Loading ammunition into artillery pieces or 5" guns. 4. Drafting - use of drafting instruments. 5. Painting - house painting or preserving ship hull, etc. 6. Marching - close order drill.

TABLE 2. TWELVE TYPES OF LEARNING ALGORITHMS WITH THE CHARACTERISTICS OF TRAINING OBJECTIVES THEY SUPPORT (continued)
(See TAEG Report 23 for actual algorithms)

NAMES OF LEARNING ALGORITHMS	CHARACTERISTICS OF TRAINING OBJECTIVES THAT CAN BE ACHIEVED WITH SPECIFIC ALGORITHMS		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
12. ATTITUDE LEARNING	Abide Accept Approve Comply Testify	1. Concerns exhibiting a pattern of behavior consistent with an attitude or value. 2. Concerns willingness to perform according to a standard as opposed to skill to perform according to that standard. (Note: A person can have a high level of skill but choose not to perform in a skillful manner.) 3. Concerns integrating or organizing a value or attitude into a pattern of behavior.	1. Complying with known safety standards while performing a maintenance procedure on a high voltage supply in a radar set. 2. Conforming to the standard of keeping one's bunk area neat and clean when the opportunity exists to do otherwise. 3. Abiding by security regulations when handling classified information. 4. Accepting the need to take risks when necessary to protect the lives of teammates. 5. Complying with a request to repair a malfunctioning radio circuit with greater than normal speed when a quick response is required.

TABLES 3 - 14

INSTRUCTIONAL DELIVERY SYSTEM SELECTION CHARTS

TABLE 3. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RECALLING BODIES OF KNOWLEDGE

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

		Alternative Instructional Delivery Systems								
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm			
Criteria for Selecting Instructional Delivery Systems		CAI	Teaching Machine - Branching	Microfiche with Self-Scoring Tests	Programmed Text - Branching with Self-Scoring Tests	Audio Visual Carrel with Program Texts, AV Modules and Self-Scoring Tests	Traditional Classroom with Instructor, Overhead Projector, Texts, and Paper and Pencil Tests	Independent Study Using Textbooks, Handbooks, Tests and Workbooks	Instructional Television Broadcast or CCTV without Feedback, Tests	Programmed Text - Linear with Instructor Scored Criterion Test
Stimulus Criteria										
● Visual Movement										
Limited		X	X			X			X	
Full		X				X			X	
● Visual Spectrum										
Full Color		X	X	X		X	X	X	X	
● Audio										
Voice Sound Range		X	X			X	X		X	
Full Sound Range						X				
Training Setting Criteria										
● Individual Trainees at Fixed Location		X	X	X	X	X	X		X	X
● Individual Trainees with Simultaneous Instruction at Many Locations									X	
● Individual Trainees with Independent Instruction at Any Location				X	X			X		X
● Small Group							X		X	
● Large Group at a Single Location							X		X	
● Team Setting										
Administrative Criteria										
● Site of Courseware and Special Hardware Development										
Local				X	X	X	X	X		X
Central		X	X	X	X	X		X	X	X
● Magnitude of Acquisition Cost										
Low				X	X		X	X		X
High		X	X			X			X	

TABLE 4. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

USING VERBAL INFORMATION

Criteria for Selecting Instructional Delivery Systems	Directions: To choose a delivery system: 1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met. 2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.	Alternative Instructional Delivery Systems								
		Delivery Approaches Permitting the Application of ALL Learning Guidelines and Algorithm						Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
		Computer Assisted Instruction with Adjunct Equipment and Materials	Programmed Text - Branching	Programmed Text - Branching with Paper Simulation	Teaching Machine - Branching Still Visual	Microfiche with Self-Scoring Tests	Tutor with Diagnostic Tests and Instructor's Guide with Student Exercises	Traditional Classroom	On-the-Job Training	
Stimulus Criteria										
● Visual Movement										
Limited		X			X			X	X	
Full		X						X	X	
● Visual Spectrum										
Full Color		X		X	X	X		X	X	
● Audio										
Voice Sound Range		X			X		X	X	X	
Full Sound Range									X	
Training Setting Criteria										
● Individual Trainees at Fixed Location		X	X	X	X	X	X		X	
● Individual Trainees with Independent Instruction at Any Location			X	X		X				
● Small Group								X		
● Large group at a single location								X		
● Team Setting									X	
Administrative Criteria										
● Site of Courseware and Special Hardware Development										
Local			X	X		X	X	X	X	
Central		X	X	X	X	X	X			
● **Magnitude of Acquisition Cost**										
Low			X	X		X	X	X	X	
High		X			X					

TABLE 5. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RULE LEARNING AND USING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems								
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm							Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm	
		Operational Equipment with Instructor and Instructor Handbook	Simulator with Instructor and Instructor Handbook	Procedure Trainer with Instructor and Instructor Handbook	Computer Assisted Instruction	Teaching Machine, Branching	Programmed Text, Branching	Microfiche with Self-Scoring Tests	Traditional Classroom	Programmed Instruction - Linear
Stimulus Criteria										
● Visual Form										
Pictorial, Plane					X	X	X	X	X	X
Line Construction, Plane					X	X	X	X	X	X
Object, Solid		X	X	X					X	
Environment		X	X	X						
● Visual Movement										
Limited			X	X	X	X			X	
Full		X	X	X	X					
● Visual Spectrum										
Gray Scale					X	X	X	X	X	X
Color		X	X	X	X	X		X	X	
● Audio										
Voice Sound Range		X	X	X	X	X			X	
Full Sound Range		X	X	X						
Ambient Sounds		X	X							
● Other										
Tactile Cues		X	X	X						
Internal Stimulus Motion Cues		X	X	X						
External Stimulus Motion Cues		X	X							
Instructional Setting Criteria										
● Individual Trainee at Fixed Location		X	X	X	X	X	X	X	X	X
● Individual Trainee with Independent Instruction at Any Location							X	X		X
● Small Group									X	
● Large Group at a Single Location									X	
Administrative Criteria										
● Site of Courseware and Special Hardware Development										
Local							X	X	X	X
Central		X	X	X	X	X	X	X		X
● Magnitude of Acquisition Cost										
Low				X		X	X	X	X	X
High		X	X	X	X	X				

TABLE 6. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

MAKING DECISIONS

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems									
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm						Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm			
		Simulator Diagnostic Tests with Instructor	Manual Simulation Game with Diagnostic Tests and Instructor	CAI with Adjunct Equipment and Materials	Teaching machine - Branching	Microfiche with Self- Scoring Tests	Programmed Text - Branching with Self-Scoring Tests	Operational System with Tutor	Case Study Materials w/wo Instructor	Role Playing Materials with Instructor	
Stimulus Criteria											
● Visual Form											
Alphanumerics			X	X	X	X	X		X	X	
Pictorial, Plain			X	X	X	X	X		X	X	
Object, Solid		X						X		X	
● Visual Movement											
Still			X	X	X	X	X		X		
Full Movement		X		X				X			
● Audio											
Voice Sound Range		X	X	X	X			X		X	
Full Sound Range		X						X			
● Other											
Tactile Cues		X						X			
External Stimuli Motion Cues		X						X			
Training Setting Criteria											
● Individual Trainee at Fixed Location		X	X	X	X	X	X	X	X		
● Independent Trainee with Independent Instruction at Any Location						X	X				
● Small Group								X	X	X	
● Team Setting		X	X					X		X	
Administrative Criteria											
● Site of Courseware and Special Hardware Development											
Local			X			X	X		X	X	
Central		X	X	X	X	X	X	X	X	X	
● Magnitude of Acquisition Cost											
Low			X			X	X		X	X	
High		X		X	X			X			

TABLE 7. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

DETECTING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems							
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
		Operational System with Stimulated Signals, and an Instructor with Instructor Handbook	Simulator with Instructor and Instructor Handbook	Simulator with Adjunct Displays and Logic	Procedure Trainer, with Instructor and Instructor Handbook	Procedure Trainer with Adjunct Displays and Logic	Operational System with Instructor	Informal On-the-Job Training on Operational System	
Stimulus Criteria									
● Full Visual Environment		X					X	X	
● Full Ambient Sounds		X	X	X			X	X	
● External Stimulus Motion Cues		X	X	X			X	X	
Training Setting Criteria									
● Individual Trainee at Fixed Location (School)		X	X	X	X	X	X		
● Individual Trainee On-the-Job		X					X	X	
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local							X	X	
Central		X	X	X	X	X			
● Magnitude of Acquisition Cost									
Low								X	
High		X	X	X	X	X	X		

TABLE 8. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

CLASSIFYING

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems										
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm					
		CAI w/Adjunct Equipment and Materials	Study Card Sets	Microfiche	Teaching Machine - Branching	Simulator with Adjunct Displays or Instructor	Slide Sets with Instructor	Traditional Classroom with AV Materials	Audio Recorders - Disc or Tape	Specimen Set	Sound Slide/Film Strip Program	
Stimulus Criteria												
● Visual Form												
Alphanumeric		X	X	X	X	X	X	X			X	
Pictorial, Plane		X	X	X	X		X	X			X	
Line Construction, Plane		X	X	X	X		X	X			X	
Object, Solid						X				X		
Environment						X						
● Visual Movement												
Still		X	X	X	X		X	X		X	X	
Limited		X			X			X			X	
Full						X		X				
● Scale												
Exact Scale						X				X		
● Audio												
Voice Sound Range		X			X	X	X	X	X		X	
Full Sound Range						X			X			
Ambient Sounds						X						
Other Tactile Cues						X				X		
Internal Stimulus Motion Cues						X						
External Stimulus Motion Cues						X						
Training Setting Criteria												
● Individual Trainee at a Fixed Location		X	X	X	X	X	X		X	X	X	
● Individual Trainee with Independent Instruction at Any Location			X	X					X		X	
● Small Group							X	X	X		X	
● Large Group at Single Location							X	X	X		X	
Administrative Criteria												
● Site of Courseware and Special Hardware Development												
Local			X	X	X		X	X	X	X	X	
Central		X	X	X	X	X	X	X	X	X	X	
● Magnitude of Acquisition Cost												
Low			X	X			X	X	X	X	X	
High		X			X	X						

TABLE 9. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

IDENTIFYING GRAPHIC SYMBOLS

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems									
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm					Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm				
		CAI (with visual display)	Teaching Machine - Branching	Programmed Text - Branching	Microfiche with Self-Scoring Tests	Study-Card Sets with Self-Scoring Tests	Traditional Classroom	Textbook	Chart	Automatic Rater	
Training Setting Criteria											
● Individual Trainee at a Fixed Location		X	X	X	X	X		X	X	X	
● Individual Trainee with Independent Instruction at Any Location				X	X	X		X	X		
Administrative Criteria											
● Site of Courseware and Special Hardware Development											
Local				X	X	X	X	X	X	X	
Central		X	X	X	X	X		X	X	X	
● Magnitude of Acquisition Cost											
Low				X	X	X	X	X	X	X	
High		X	X								

TABLE 10. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

VOICE COMMUNICATING

Directions:

To choose a delivery system:

1. Place a "√" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "√". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems							
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm			Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm				
		Simulator with Instructor, Instructor Handbook, and Diagnostic Tests	Procedure Trainer with Instructor, Instructor Handbook and Diagnostic Tests	Language Laboratory, Audio, Active-Compare Mode, with Manual Simulation Game and Instructor	Language Laboratory, Audio, Active-Compare Mode, with Printed Materials	Performance Aid	Traditional Classroom	Operational Equipment in Real Environment with Instructor	
Stimulus Criteria									
● Visual Form									
Pictorial, Plane				X	X	X	X		
Solid Object		X	X					X	
● Visual Movement									
Still				X	X	X	X		
Full Movement		X	X					X	
● Audio									
Voice Sound Range		X	X	X	X		X	X	
Ambient Sounds		X	X	X	X			X	
Training Setting Criteria									
● Individual Trainee at a Fixed Location		X	X	X	X		X	X	
● Individual Trainee with Independent Instruction at Any Location						X			
● Team Setting		X	X	X		X		X	
Administrative Criteria									
● Site of Courseware and Special Hardware Development									
Local						X	X	X	
Central		X	X	X	X	X			
● Magnitude of Acquisition Cost									
Low				X	X	X	X		
High		X	X					X	

TABLE 11. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

RECALLING PROCEDURES AND POSITIONING MOVEMENT

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems											
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm								Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm			
		Operational System in Laboratory with Tutor	Simulator with Tutor and Tests	Procedures Trainer with Tutor and Tests	Logic Trainer with Tutor	CAI with Photo or Operable Mockup	Teaching Machine with Photo or Operable Mockup	Microfiche w/wo Photo or Operable Mockup	Programmed Text - Branching	Laboratory Carrel with Equipment and Linear Instructional Materials	Operational System in Real Environment with Tutor	Texts, Lectures and Demonstrations	
Complexity Criteria													
● Difficult Motor Acts		X	X	X	X					X	X		
● Smooth Motor Performance at End of Training		X	X	X						X	X		
Stimulus Criteria													
● Visual Form													
Alpha-Numeric		X	X	X	X	X	X	X	X	X		X	
Pictorial, Plane					X	X	X	X	X	X		X	
Object, Solid		X	X	X	X					X	X	X	
● Visual Movement													
Still					X	X	X	X	X	X		X	
Full Movement		X	X	X	X	X				X	X		
● Audio													
Voice Sound Range		X	X	X		X				X	X	X	
Full Sound Range		X	X	X						X	X		
Ambient Sounds		X	X	X							X		
● Other													
Tactile Cues		X	X	X						X	X		
Internal Stimulus Motion Cues		X	X	X						X	X		
Training Setting Criteria													
● Individual Trainee at Fixed Location		X	X	X	X	X	X	X	X	X	X	X	
● Individual Trainee with Independent Instruction at Any Location								X	X				
● Small Group					X							X	
● Large Group at Single Location												X	
● Team Setting		X	X	X	X						X		
Administrative Criteria													
● Site of Courseware and Special Hardware Development													
Local								X	X	X	X	X	
Central		X	X	X	X	X	X	X	X	X	X		
● Magnitude of Acquisition Cost													
Low								X	X	X		X	
High		X	X	X	X	X	X			X	X		

TABLE 12. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

STEERING & GUIDING — CONTINUOUS MOVEMENT

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

		Alternative Instructional Delivery Systems					
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm				Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm	
Criteria for Selecting Instructional Delivery Systems		Operational System, Real Environment with Instructor and Instructor Handbook	Simulator with Motion Platform and Full Visual Field, Instructor and Instructor Handbook	Simulator (Without Motion Platform and Full Visual Field) Instructor and Instructor Handbook	Procedure Trainer, Instructor and Instructor Handbook	Operational System, Real Environment, Without Instructor	
Stimulus Criteria							
Full Visual Environment		X	X			X	
External Stimulus Motion Cues		X	X			X	
Fine Movement Manipulative Acts		X	X	X		X	
Broad Movement Manipulative Acts		X	X	X	X	X	
Training Setting Criteria							
Individual or Team Training at a Fixed Location		X	X	X	X	X	
Individual or Team Training with Independent Instruction at Many Locations		X				X	
Administrative Criteria							
Site of Courseware and Special Hardware Development							
Local		X				X	
Central		X	X	X	X	X	

TABLE 13. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

PERFORMING GROSS MOTOR SKILLS

Directions:

To choose a delivery system:

1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met.

2. Select the delivery systems (columns) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.

Criteria for Selecting Instructional Delivery Systems		Alternative Instructional Delivery Systems				
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm		Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm		
		Tutor in a Job-Like Setting with Equipment, if required, an Instructor Handbook and Student Diagnostic Tests	Tutor in a Job-Like Setting with equipment, if required, an Instructor Handbook, Student Diagnostic Tests, and Portable TV with a Record/Playback Capability and a Series of Taped Demonstrations	Programmed Text - Branching and a Series of Film Loops with Equipment, if required, and a Part-Time Instructor with Criterion Tests	Supervisor Managed Informal On-The-Job Training	
Training Setting Criteria						
● Individual Trainee at a Fixed Location		X	X	X		
● Individual Trainee with Independent Instruction at Many Locations				X	X	
● Small Group					X	
● Team Setting		X	X		X	
Administrative Criteria						
● Site of Courseware Development						
Local		X	X	X	X	
Central		X	X	X		

TABLE 14. INSTRUCTIONAL DELIVERY SYSTEM CHART FOR THE ALGORITHM

This chart is useful in selecting an instructional delivery system for the affective and behavioral components of attitude learning. For achieving the cognition component use instructional delivery systems suggested for recalling bodies of knowledge

ATTITUDE LEARNING

Criteria for Selecting Instructional Delivery Systems	Directions: To choose a delivery system: 1. Place a "✓" (light pencil) in boxes representing criteria (rows) that must be met. 2. Select the delivery systems (column) that have an "X" in each row designated by a "✓". These are the candidate delivery systems.	Alternative Instructional Delivery Systems						
		Delivery Approaches Permitting the Application of All Learning Guidelines and Algorithm		Delivery Approaches NOT Permitting Complete Application of Learning Guidelines and Algorithm				
		Operational Job Setting with Instructor and Instructor Handbook with Diagnostic Attitude Tests	Simulated Job Setting with Instructor and Instructor Handbook with Diagnostic Attitude Tests	Roll Playing	Case Studies	On-The-Job Training by Supervisors	Lectures, Seminars, etc.	
Training Setting Criteria								
● Individual Trainee at Fixed Location		X	X		X			
● Individual Trainee with Independent Instruction at Many Locations						X	X	
● Small Group		X	X	X	X	X	X	
● Team Setting		X	X	X	X	X	X	
Administrative Criteria								
● Site of Courseware Development								
Local		X		X	X	X	X	
Central		X	X	X	X			
● Magnitude of Acquisition Cost								
Low				X	X	X	X	
High		X	X					

APPENDIX A

ALTERNATE APPROACH FOR STEP 2

APPENDIX A

ALTERNATE APPROACH FOR STEP TWO

Step 2, as presented in section III, is a "by-the-numbers" procedure. It is a simple sequence of events for selecting delivery systems, but in its simplicity it eliminates the chance for innovation or for a sensitive response to special conditions. An alternative approach restores the possibility of responding to special conditions. The alternate approach contains the following steps:

First, study the appropriate set of learning guidelines and algorithms in TAEG Report 23.[9] Modify the algorithms, as required, to accommodate the required training tasks.

Second, list those media characteristics from table 15, Generic Characteristics of Training Media, required to carry out the intent of the algorithm with the training objectives. As an example, a specific training objective matched with an algorithm may require an instructional delivery system with the following set of basic characteristics.

Visual form:

- Visual alphanumeric
- Visual pictorial plane

Visual Movement:

- Visual still

Visual Spectrum:

- Color

Audio:

- Voice sound range

Trainee Response Modes:

- Multiple choice

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[9] James A. Aagard and Richard Braby, Learning Guidelines and Algorithms for Twelve Types of Training Objectives, TAEG Report No. 23. Training Analysis and Evaluation Group, Orlando, Florida (manuscript form, to be published mid-1975).

TABLE 15. GENERIC CHARACTERISTICS OF TRAINING MEDIA

STIMULUS CAPABILITIES

Visual Form

1. Visual Alphanumeric - words, numbers and other symbols presented graphically.

2. Visual Pictorial, Plane - a two-dimensional image, a representation in the form of a photograph or drawing.

3. Visual Line Construction, Plane - a two-dimensional figure made of lines, such as a mathematical curve or graph.

4. Visual Object, Solid - a three-dimensional image or reality that is viewed from exterior perspectives.

5. Visual Environment - A three-dimensional image or reality that is viewed from inside.

Visual Movement

6. Visual Still - a static visual field, as with a still photograph, drawing, or printed page.

7. Visual Limited Movement - a basically static visual field with elements that can be made to move, as with an animated transparency or simple panel with switches that move.

8. Visual Full Movement - a visual field in which all elements can move, as with a motion picture, flight simulator, or operational aircraft.

9. Visual Cyclic Movement - a visual field which moves through a fixed sequence and then repeats the sequence in a repetitive manner, as with a film loop.

Visual Spectrum

10. Black and White - a visual field composed of either black or white elements, as with the printed page or line drawings.

11. Gray Scale - a visual field composed of black, white and continuous gradations of gray, as with a black and white photograph or television picture.

12. Color - a visual field composed of various segments of the visual spectrum, as with color television or motion pictures.

Scale

13. Exact Scale - actual visual field or a one-to-one replication of that field as with a full-sized mock-up, simulator, or operational system.

14. Proportional Scale - a representation of reality in other than full scale, such as a scaled model map or photograph.

Audio

15. Voice Sound Range - a limited quality of sound which enables spoken words to be used as the medium of communications, but not suited to more demanding tasks, such as music or sound recognition exercises.

16. Full Sound Range - a quality of sound reproduction that contains all the significant elements of the sound and is suited to the demanding task of sound recognition exercises.

17. Ambient Sounds - a complex sound environment with sounds emanating from various sources and from various directions, including background noise and task significant sounds.

Other

18. Tactile Cues - signals received through the sense of touch, including sensations related to texture, size or shape.

19. Internal Stimulus Motion Cues - the sensations felt by a person when he moves his arm, leg, fingers, etc.

20. External Stimulus Motion Cues - the sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

TRAINEE RESPONSE MODES

21. Covert Response - a response which the trainee creates in his mind but does not express in an observable manner.

22. Multiple Choice - a response mode in which a trainee selects a response from a limited set of responses.

23. Pre-programmed Verbal Performance - a response mode in which a trainee creates a short answer to a question having a limited set of correct answers.

24. Free-Style Written Performance - a response mode in which a trainee writes a response in his own words.

25. Decision Indicator - a verbal or perceptual motor response in which the trainee indicates that he has made a divergent type decision.

26. Voice Performance - a response mode in which a trainee speaks, including conversation.

27. Fine Movement Manipulative Acts - a response mode in which a trainee makes discrete and small movements of dials, switches, keys or makes sensitive adjustments to instruments. Act may involve use of small instruments.

28. Broad Movement Manipulative Acts - a response mode in which a trainee makes large movements of levers or wheels on large pieces of equipment or by the use of hand held tools.

29. Tracking - a response mode in which a trainee continuously controls a constantly changing system, such as steering an automobile or holding a compass bearing in steering a ship.

30. Procedural Manipulative Acts - a response mode in which a trainee performs the sequence of steps in a procedure, such as in the carrying out of the items on the checklist for pre-flighting an aircraft or turning on a radar system.

TABLE 15. GENERIC CHARACTERISTICS OF TRAINING MEDIA (continued)

INFORMATION FEEDBACK LOGIC

Form of Feedback

31. Intrinsic Feedback - information the trainee receives from his own internal movements or from proprioceptive stimulation.

32. Action Feedback - externally displayed cues inherent in the task, including such forms as instrument indications and the display of answers to questions as in linear programmed instruction.

33. Augmented Feedback - immediate presentation of information to the trainee on how the results of his performance conform to some criterion or an objective reference.

34. Reconstruction Feedback - critical analysis or evaluation of trainee performance, usually at the completion of an exercise or a significant block of instruction.

Content of Feedback

35. Correct Response Data - an indication of correct response is provided the trainee either immediately after he responds or automatically in the event he does not respond within a specified time.

36. Score Data - the trainee receives quantitative information about his performance (such as amount, percent and rate data).

37. Diagnostic Data - the trainee is informed of inadequate performance, its cause, and prescribed remedial actions.

38. System Performance Data - the trainee observes changes in the state of a system as a consequence of his actions in the system.

Time Schedule for Feedback

39. Immediate - feedback provided in continuity with a trainee's action, either continuously as accrued or at the conclusion of each student response.

40. Fixed - feedback provided to the trainee at prescribed times, such as at the end of an exercise or at timed intervals.

41. Variable - feedback provided to a trainee according to a variable schedule which may change as a function of stage of training or level of performance. This includes the provision for intermittent presentations to permit probabilistic schedules of reinforcement.

EVENT SEQUENCE LOGIC

42. Linear - a fixed sequence of instructional events, as in linear programmed instruction and motion pictures.

43. Cyclic - a special case of linear sequence in which a limited segment of a linear program is repeated continuously throughout a period of time, as with a film loop.

44. Branching - a sequencing of instructional events with the trainee routed to appropriate advanced or remedial material based upon his answers to diagnostic questions imbedded at intervals in the material.

45. Automated (Machine) Adaptive - an automatic sequencing and pacing of events designed to keep a trainee at the threshold level of his ability to learn at all times.

46. Instructor Selected Sequence - the ordering of events by the instructor, such as in a lecture-recitation period in the traditional classroom or in tutoring.

47. Trainee-Initiated Inquiry - the selection, sequencing and pacing of learning events by the trainee.

48. Dynamic Modeling - system programming in the form of a simulation model which enables the trainee to exercise the model and observe the corresponding effects.

INSTRUCTIONAL SETTING

49. Individual Trainee at Fixed Location - a fixed study position for individualized instruction, such as in a school with carrels or CAI terminals.

50. Individual Trainees with Simultaneous Instruction at Many Locations - any site that can be used with a telecommunication mode of instruction, as with scheduled radio or broadcast television.

51. Individual Trainee with Independent Instruction at Any Location - any site that can be used by a student for independent study as with books or programmed instruction texts.

52. Small Group - a meeting site accommodating up to 15 people, enabling small group dynamics to function; both leaderless and leader-directed groups; a small classroom.

53. Large Group at Single Location - a meeting site for more than 15 people, such as a large classroom or auditorium.

54. Large Groups at Dispersed Locations - two or more group meeting sites that can be linked with communication equipment for a common training program, as with two-way closed circuit TV between classrooms at two different schools.

55. Team Setting - a single site that is equipped to enable a group of individuals to perform as a team, as in a weapon system simulator or operational system.

Form of Feedback:

Action feedback

Content of Feedback:

Correct response data
Score data

Time Schedule of Feedback:

Immediate
Variable

Event Sequence Logic:

Branching

Instructional setting:

Individual trainee at fixed location.

Third, review the contents of table 16, Media Pool, and consider instructor roles required for the use of these media. Devise combinations of media and instructor resources that can carry out the intent of the algorithm with the training objectives. List and describe these different combinations as alternative instructional delivery systems.

The Media Pool is a list of 89 types of instructonal media. The list contains a broad range of types of media, including media in various stages of development, from operational forms to those under development, and some that have yet to reach the prototype or pilot program stage. It is organized into seven categories. The categories are printed material, audio-only systems, visual-only systems, audio-visual systems, CAI/CMI, simulated and operational systems, and special or nonstandard items. Within each category, the media are listed alphabetically. While this is not an exhaustive list of types of instructional media, it contains the major forms being used or being considered for use in military training systems.

Fourth, reject those that fail the practicality test, described in Step 2 of the primary procedure.

Conceiving instructional delivery systems using this alternative approach is a highly creative task requiring expert knowledge of the subject matter, the guidelines, algorithms, and potential delivery systems, as well as an awareness of the local conditions at the training site. It requires a high level of professionalism on the part of the training systems design team.

TABLE 16. MEDIA POOL

PRINT MATERIALS

CASE STUDY FOLDER - A folder of detailed background information on a problem requiring a decision or plan of action; to be read by the trainee prior to his (1) making a decision on how to resolve the issue and (2) participating in a critique on various solutions. Various forms of folders are used in support of such methods of instruction as the Case Study, Incident and In-Basket methods of management and leadership training.

FLASH CARDS - A set of cards designed to be used by an instructor in front of a group of trainees to drill the group in the recall of memory type information.

PRINTED MATERIALS - HANDOUTS - Handouts are a class of printed materials issued to a student for his use and retention to augment regular instructional materials. They are usually instructor prepared, machine copied materials of one or two pages highlighting specific topics or updating existing materials.

PRINTED MATERIALS - PERFORMANCE AIDS - Performance aids are a class of printed materials that aid in job performance by providing data that should not be committed to memory. They include checklist routines, conversion tables, equipment test tolerance matrices and the like.

PRINTED MATERIALS - REFERENCE BOOKS - Reference books are a class of printed materials used to identify certain facts or for background information such as dictionaries, encyclopedias or technical publications.

PRINTED MATERIALS - REFERENCE CHARTS - Reference charts are a class of printed material pictorially displaying data used to identify certain facts or for background information. Included are data charts, schematic diagrams, topographical maps and the like.

PRINTED MATERIALS - SELF-SCORING EXERCISES - Self-scoring materials include exercises and quizzes used in conjunction with standard curriculum, or programmed instruction. The class includes electrographic or mark sense materials scored by keys or computer, punch mark and other mechanical score indicating equipments, chemically scored materials, etc., that have the capability of providing near immediate student feedback without the use of prolonged scoring procedures.

TABLE 16. MEDIA POOL (continued)

DIAL ACCESS INFORMATION RETRIEVAL SYSTEM - RANDOM AUDIO - Dial access information retrieval is an electronic system for distributing audio (and/or visual) materials and programs which are stored in a location remote from where they are dialed and received. Random audio means that audio materials are retrievable at any time by electronically triggering a tape duplicating machine that makes a student copy from a master tape within the library.

DIAL ACCESS INFORMATION RETRIEVAL SYSTEM - SCHEDULED AUDIO - Scheduled audio means that audio materials may be dialed at any time, but once a program has begun, subsequent users must join the program in progress.

LANGUAGE LABORATORY - AUDIO, ACTIVE - COMPARE MODE - An audio presentational device that distributes audio information via a control console to student stations equipped with headsets, microphone for console/instructor-student inter-communication, and a tape recorder. Student may interact with taped instructional material, rewind and play back or store responses. Student responses may be monitored or recorded at console.

LANGUAGE LABORATORY - AUDIO PASSIVE MODE - An audio presentational device that distributes audio information from a control console to student stations equipped with headsets. Audio source may be a phonograph record, a taped recording, or a motion picture sound track.

PHYSIOLOGICAL TRAINER (HOSTILE ENVIRONMENT) AUDITORY - A training device designed to place controlled stress on the human hearing system through use of a physiologically and/or psychologically adverse sound environment, to enable a trainee to learn to function in this adverse environment.

RADIO SYSTEM - AM/FM - A passive audio system consisting of a broadcast studio, transmitting station, and student radio receivers. The system uses designated AM/FM frequency bands for information transmission.

RADIO SYSTEM WITH RESPONDERS - A multi-channel two-way radio communication system that operates within UHF or VHF-FM frequency bands limiting broadcast ranges. Network may be open or use encoding/decoding techniques or responders for individual channel privacy.

TABLE 16. MEDIA POOL (continued)

TELEPHONE CONFERENCE SYSTEM - A telephone system with switching matrix capability that allows multiple station two-way audio communication at two or more remote locations.

VISUAL ONLY SYSTEMS

FILMSTRIP PROJECTION SYSTEM - A single frame projector or attachment thereto that will accept a filmstrip format and project the film images upon a viewing screen. See: Sound Filmstrip Projection System.

MICROFORM WITH INFORMATION MAPPING - Microimagery, such as microfilm, used as a medium of instruction with the additional requirement that each block of information be clearly identified as introduction, overview, test, review questions, index and other discrete titles, and that each type of information be positioned in a standard location within the medium format.

MICROFORM WITH INFORMATION MAPPING AND ADJUNCT EQUIPMENT - The theoretical configuration of a training system to support individualized instruction composed of microimagery in an information map format, a microform reader, and a piece of auxiliary equipment, such as a mock-up, which is the subject of the instruction.

MOCK-UPS, PANELS, AND DEMONSTRATORS - DYNAMIC - A visual training aid that allows an instructor to demonstrate manipulative principle, movement in time or space, steps of a procedure, linear effect within systems or changes in condition of equipment or systems through one or more operating phases.

MODELS AND STATIC MOCK-UPS - SMALL SCALE - A three-dimensional training aid built to scale and representing operational equipment. It may be a solid or cutaway model capable of disassembly by which spatial and/or sequential relationships are represented. Also included are layout models, recognition model sets, and terrain or topographical models.

MOCK-UPS, PANELS AND DEMONSTRATORS - STATIC - A training aid used to demonstrate relative shape, size, composition or function of an object or system by a visual-cognitive process performed by the trainee. Such non-moving, real or "scaled" aids include cutaway models, diagrams, blow-apart hardware displays, etc.

SLIDE PROJECTOR SYSTEM - 2" X 2" - A class of single frame picture projectors that will accept a standard 2" X 2" slide and project the contained image upon a viewing screen.

TABLE 16. MEDIA POOL (continued)

PRINTED MATERIAL - WORKBOOK - Workbooks are a class of printed material used to augment or replace instructional texts by providing a mix of text information and practice exercises within a single book or manual.

PRINTED MATERIAL - TEXTBOOK - Textbooks are a class of printed material dealing with a subject of study, intended for use at a specified level of instruction and used as a principal source of organized information.

PROGRAMMED TEXT - BRANCHING - A printed text containing frames of information and multiple choice questions concerning the information, organized in such a way that the trainee's choice of response directs him to remedial frames or advanced material, as appropriate. The material is carefully sequenced, tested and revised to ensure that a specific student population will achieve stated behavioral objectives with a predetermined level of success.

PROGRAMMED TEXT - BRANCHING WITH ADJUNCT MATERIAL/EQUIPMENT - A form of program in which additional materials such as drawings, catalogues, or equipment are used with the regular branching programmed text.

PROGRAMMED TEXT - LINEAR - A printed text containing a fixed sequence of small frames of information usually in the form of questions requiring the trainee to construct a simple written response, which is immediately evaluated. The material is carefully sequenced, tested, and revised to ensure that a specific student population will achieve stated behavioral objectives with a predetermined level of success.

PROGRAMMED TEXT - LINEAR WITH ADJUNCT MATERIAL/EQUIPMENT - A form of program in which additional material such as drawings, catalogues, or equipment are used with the regular linear programmed text.

STUDY CARD SETS - A deck or decks of cards designed to present training information to an individual student.

AUDIO ONLY SYSTEMS

AUDIO DISC PLAYBACK SYSTEM - An audio system that uses a record player and sound recorded on a disc (record) that may be played back by a listener.

AUDIO TAPE SYSTEM - An audio system that uses a tape recorder/reproducer to record sound on magnetic tape that may be played back upon request by a listener.

TABLE 16. MEDIA POOL (continued)

SIMULATION - PAPER - The representation of selected dynamic characteristics of a system through the use of charts, tables, static photographs, drawings, and lists of performance characteristics under specified conditions. This information is presented in such a way that the trainee can study the initial performance of the system, change inputs to or elements within the system and note changes in the performance of the system.

TEACHING MACHINE - LINEAR, STILL VISUAL - An individualized instruction system composed of a fixed linear sequence of small step programmed instruction frames (still) and a manually controlled device to display the information.

TEACHING MACHINE - BRANCHING, STILL VISUAL - An individualized instruction system composed of large step multiple choice programmed instruction frames (still) and a manually controlled device to select, sequence and display program frames in an order dependent upon the trainee's last response.

AUDIO-VISUAL SYSTEMS

AUDIO TAPE WITH PRINTED MATERIAL - An audio system that uses a tape recorder/reproducer to record sound on magnetic tape that may be played back upon request. Printed materials such as texts, worksheets, PI, schematics, test materials, etc., used with audio tapes offer a variety of training applications.

CARREL - AV EQUIPPED - A small enclosure or alcove incorporating a desk used for individual studies, supplied with audio and visual materials and supporting equipment.

CARREL - LABORATORY - A small enclosure or alcove incorporating a desk, to be used by one or two trainees and equipped with a set of special tools and material for carrying out a hands-on learning event. It may include audio-visual systems.

DIAL ACCESS INFORMATION RETRIEVAL SYSTEM - SCHEDULED AUDIO/VIDEO - Dial access information retrieval is an electronic system for distributing audio and visual materials and programs which are stored in a location remote from where they are dialed and received. Scheduled audio/video means that presentations are retrievable at any time except that once a program has begun, subsequent users must join the program in progress.

TABLE 16. MEDIA POOL (continued)

FILMSTRIP PROJECTION SYSTEM WITH AUDIO - A sound filmstrip projector represents a family of audio-visual devices using single frame visual filmstrips with sound on magnetic tape or records. Visuals and sound may be manually or automatically synchronized. Commercial equipment options include front or rear screen projection, remote and stop action capability, and cartridge loading models.

FILMSTRIP PROJECTION SYSTEM WITH AUDIO AND ADJUNCT EQUIPMENT - A system for presenting information via a filmstrip projector and synchronized audio tape and special equipment that is the subject of study. The use of adjunct equipment with the AV media provides the capability for a variety of "hands-on" training tasks to be performed.

INSTRUCTIONAL KIT WITH INSTRUCTOR - A teaching kit designed for specific subject area instructional support. Kit allows the instructor to use a varied or multi-level teaching approach to instruction by including appropriate visual aids, audio tapes, models, charts, demonstrators, reference and test materials.

INSTRUCTIONAL KITS FOR TRAINEES - A modular package of materials for students that contains all materials required for a segment of instruction. Kit may contain programmed instruction, audio-visual materials, tools, materials, typical samples, reference materials and testing materials as appropriate.

MOTION PICTURE PROJECTION SYSTEM - COMMERCIAL, 16MM AND SUPER 8MM FILMS - A motion picture projection system implying the use of professionally prepared 16mm or S-8mm sound motion picture films for training. Appropriate 16mm or S-8mm projector and projection screen are included.

MOTION PICTURE PROJECTION SYSTEM - LOW BUDGET 16MM AND SUPER 8MM FILMS - A motion picture projection system implying the use of locally produced sound motion picture films for training. Such films are acceptable for training, but often lack the professional quality of commercial films. Appropriate 16mm or S-8mm projector and projection screen are included.

MICROFORM WITH INFORMATION MAPPING, AND AUDIO - The theoretical configuration of a training system to support individualized instruction composed of microimagery in an information map format, a microform reader, an audio tape in a cassette and an audio cassette playback unit.

TABLE 16. MEDIA POOL (continued)

OVERHEAD PROJECTION SYSTEM WITH INSTRUCTOR - A system consisting of a horizontal stage projector designed to use a vertical throw for focusing an enlarged transparency image upon a projection screen. An operator is normally required to change the transparency and furnish verbal commentary.

SOUND SLIDE PROJECTION SYSTEM - A system for presenting information by means of an audio tape and a series of synchronized projected visual slides.

STUDENT RESPONSE SYSTEM - AV SUPPORTED - A student feedback response system using programmed audio and/or visual presentations. It consists of four major components: control console with response readouts, student responders, audio visual devices, and a programmer. Options include paper tape readouts and computer interface terminals.

TEACHING MACHINE - BRANCHING, STILL VISUAL WITH AUDIO - An individualized instruction system composed of large step multiple choice programmed instruction frames (still) with synchronized sound and a manually controlled device to select, sequence and display program frames in an order dependent upon the trainee's last response.

TEACHING MACHINE - BRANCHING, STILL AND MOTION VISUAL WITH AUDIO - An individualized instruction system composed of large step multiple choice programmed instruction frames (still and motion) with synchronized sound and a manually controlled device to select, sequence and display program frames in an order dependent upon the trainee's last response.

TEACHING MACHINE - BRANCHING, WITH ADJUNCT EQUIPMENT - An individualized instruction system composed of large step multiple choice programmed instruction frames (still or motion with or without audio) with a manually controlled device to select sequence and display program frames in an order dependent upon the trainee's last response. Associated with this equipment is a second piece of equipment, such as a mock-up, which is the subject of instruction and is operated according to instructions from the basic teaching machine.

TEACHING MACHINE - LINEAR, STILL VISUAL WITH AUDIO - An individualized instruction system composed of a fixed linear sequence of small step programmed instruction frames (still and motion) with synchronized audio, and a manually controlled device to display the audio and visual information.

TABLE 16. MEDIA POOL (continued)

TELECONFERENCE SYSTEM - A telecommunication system that allows audio and visual two-way communication between two or more remote locations.

TELEVISION - CABLE (CATV) - A hybrid CCTV system offering selective, multiple channel, encoded programming to cable network patrons. A typical system consists of a signal receiving antenna system for the master station and relay of amplified signal channels via area substations to system subscribers. Programming may also be generated and transmitted between substations offering multiple options for conference or training. Programs are encoded for privacy and control of viewing audience.

TELEVISION - CARTRIDGE (CTV) - A cartridge television system (CTV) consists of packaged video tape programs, video recorder, playback and display units, and control equipment offering high selectivity and availability for individualized programming. Program cartridges may be prerecorded, locally produced, or recorded off-the-air.

TELEVISION - CLOSED CIRCUIT (CCTV) WITHOUT FEEDBACK - CCTV without feedback is an electronic transmission system for images and sound using a coaxial cable distribution system. System design includes one or more studios or control rooms, a signal distribution center, and signal distribution cables terminating in reception areas equipped with receiver/monitors. Off air, live or video taped programs may be used.

TELEVISION - CCTV WITH FEEDBACK - CCTV with feedback is the transmission of a live presentation with audio feedback via microphone or telephone in each receiving classroom. Live instructor is required in student-instructor-CCTV loop to activate the feedback mode.

TELEVISION - NON-MAGNETIC VIDEO DISC SYSTEM - An experimental form of television, similar in function to cartridge television, in which the program is encoded on a thin plastic disc, distributed to users where it is rotated at high revolutions per minute on a player which reads the data and sends program signals into the antenna terminals of a standard color television receiver. Random access capability.

TELEVISION - OPEN BROADCAST - Open broadcast television is the electronic transmission of images with accompanying sound from a single channel VHF and UHF station and shorter range multiple channel 2500 MHZ systems.

TABLE 16. MEDIA POOL (continued)

TELEVISION - PORTABLE VIDEO TAPE SYSTEM - A low cost video tape recording and playback system which is self-contained and portable. Typical systems consist of one or two mobile vidicon cameras, a small scan video tape recorder and a monitor receiver. Immediate area programming and open broadcast reception and recording is standard.

TELEVISION - VIDEO DISC WITH ADJUNCT EQUIPMENT - A theoretical configuration of a video disc system in which random access capabilities are used by a trainee in retrieving step-by-step procedures and diagnostic routines as an aid in performing these operations on a piece of equipment.

CAI/CMI

COMPUTER ASSISTED INSTRUCTION (CAI) - A form of individualized instruction that employs digital computer technology to manage and display information to a student, accept student responses, provide knowledge of results, and select subsequent learning event.

COMPUTER ASSISTED INSTRUCTION - PLATO IV BASIC CONFIGURATION - An individualized computer based teaching system being developed by the University of Illinois at Urbana-Champaign, and includes up to 4096 terminals, a communication network, a central computer and the author language TUTOR.

COMPUTER ASSISTED INSTRUCTION - PLATO IV, BASIC CONFIGURATION AND AUDIO - System includes basic configuration of PLATO IV plus a random access audio playback system.

COMPUTER ASSISTED INSTRUCTION - PLATO IV, BASIC CONFIGURATION WITH ADJUNCT EQUIPMENT - Includes the basic terminal with externally connected auxiliary equipment.

COMPUTER ASSISTED INSTRUCTION - PLATO IV BASIC CONFIGURATION WITH ADJUNCT EQUIPMENT AND AUDIO - The basic terminal with externally connected auxiliary equipment including a random access audio playback system.

COMPUTER ASSISTED INSTRUCTION (CAI/CMI) TICCIT - A CAI system designed by Mitre Corporation which allows the student to manage his own instruction.

COMPUTER MANAGED INSTRUCTION (CMI) - A student management system in which a computer receives information about student achievement from terminals on- or off-line and directs the student to a sequence of off-line learning modules suited to the student's style of learning and level of achievement.

TABLE 16. MEDIA POOL (continued)

SIMULATED AND OPERATIONAL SYSTEMS

COMPUTER SIMULATION - ON-LINE - A trainee station equipped with a computer terminal in which the trainee operates in direct interface with the computer as part of the program loop. By his inputs, the trainee determines his allowable performance parameters and discerns the effect of his inputs upon the system being simulated.

COMPUTER SIMULATION - OFF-LINE - A trainee station equipped with a computer terminal enabling a trainee to select a computer simulation program, enter his own variables (batch processing) and run the simulation to determine the performance of the simulated system under a variety of conditions.

GAME - COMPUTER SUPPORTED SIMULATION - Any contest, governed by rules, between teams or individuals, where the contest is a dynamic model of some real system, and a computer is used in performing some of the calculations necessary for the operation of the model as in computer supported war gaming.

GAME - MANUAL SIMULATION - Any contest between teams or individual players, governed by rules, where the contest is a dynamic model of some real system, and is played without the aid of a computer.

LOGIC TRAINERS - A class of trainers that synthetically allow electronic, mechanical, fluid or gaseous conceptual system logic training without the use of actual hardware.

GAME - COMPUTER SIMULATION, SOLITAIRE, WITH VISUAL DISPLAY - Any contest, governed by rules, between a single player and a computer with visual attachments where the contest is a dynamic model of some real world system or event.

OPERATIONAL EQUIPMENT WITH MANUALS - A unit of operational equipment being used for instructional or training purposes with its supporting technical documentation such as operator's guides, maintenance manuals and parts lists. May be an electronic black box, rifle, or truck.

OPERATIONAL SYSTEM - REAL ENVIRONMENT - An operational system used for training such as an aircraft, ship or track vehicle. Part task, full task, sub-team, team or multi-team training may be conducted in conjunction with or independent of normal operations.

TABLE 16. MEDIA POOL (continued)

OPERATIONAL SYSTEM - SYNTHETICALLY STIMULATED - An operational system that is used for training by interfacing input equipments in the form of tapes, black boxes, or computers. Such input equipments present programmed data to the operational system allowing it to be used for training or evaluative purposes. May be used for part task, full task, sub-team, multi-team training or combinations thereof.

PHYSIOLOGICAL TRAINER (HOSTILE ENVIRONMENT) VISUAL - A training device designed to place controlled stress on the human visual system, through the use of physiologically and/or psychologically adverse or low threshold visual signals, to enable a trainee to learn to function in this adverse environment.

PHYSIOLOGICAL TRAINER (HOSTILE ENVIRONMENT) SURFACE AND INTERNAL SENSES - A broad category of training devices designed to provide the cutaneous, kinesthetic and olfactory sensors with physiologically and/or psychologically adverse signals, to enable a trainee to function in adverse pressure, temperature, pain or disorientating motion environments.

PROCEDURE TRAINER - Training hardware designed for basic training, familiarization or transition type procedure training for normal, alternate and emergency operation of operational hardware. Trainer systems respond with a lesser degree of fidelity of performance than is required for simulators. May be used for various combinations of part task, full task, sub-team, team or multi-team training.

PROCEDURE TRAINER - ADJUNCT DISPLAYS AND LOGIC - Training hardware designed for basic training, familiarization or transition type procedure training for normal, alternate and emergency operation of operational hardware. Trainer systems respond appropriately to trainee inputs but to a lesser degree of fidelity of performance than is required for simulators. May be used for various combinations of part task, full task, sub-team, team or multi-team training. Adjunct displays and logics may include scoring attachments, adaptive control, automatic demonstrations, enhanced displays, automated briefing and debriefing capability, automatic coaching, remedial exercise prescriptions or follow-on assignments.

SIMULATOR - Training hardware that is designed specifically for training purposes to simulate operational equipment/systems or portions thereof, and which simulates the operational environment in a training situation. When operated, it becomes a dynamic model of

TABLE 16. MEDIA POOL (continued)

the appearance and performance of selected aspects of the operational equipment/system. May be designed for part task, full task, sub-team, team, multi-team training or combinations thereof.

SIMULATOR - ADJUNCT DISPLAYS AND LOGIC - Training hardware that is designed specifically for training purposes to simulate operational equipment/systems or portions thereof, and which simulates the operational environment in a training situation. When operated, it becomes a dynamic model of the appearance and performance of selected aspects of the operational equipment/system. May be designed for part task, full task, sub-team, team, multi-team training or combinations thereof. Adjunct displays and logics may include scoring attachments, adaptive control, automatic demonstrations, enhanced displays, automated briefing and debriefing capability, automatic coaching, remedial exercise prescriptions or follow-on assignments.

SPECIAL AND NON-STANDARD ITEMS

AUTOMATIC RATERS - INFORMAL TRAINING - A class of electromechanical response rating devices used primarily for informal refresher type training. Typically, a gaming approach is used to offer multiple choice type questions to the trainee. Immediate feedback upon answer choice selection is given in the form of right, wrong, or item score as well as cumulative score.

CARREL - DRY - A small enclosure or alcove incorporating a desk, used for individual studies, without audio-visual or laboratory equipment.

CLASSROOM - TRADITIONAL - A classroom designed and equipped for an instructor to lecture, lead group discussions, conduct paper and pencil tests and use instructor controlled audio-visual aids.

DO-IT-YOURSELF KITS - A type of instructional kit containing instructions and materials for fabricating a usable product. Such a kit offers practical "hands-on" training following theoretical training.

GAME - MANUAL NON-SIMULATION - Any contest between teams of individual players, governed by rules, where the contest is not a dynamic model of some real system, and is played without the aid of a computer.

SPECIMEN SETS - An instructional kit containing samples of similar items, liquids or materials that may be tested or evaluated for identification, quality or type.

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APPENDIX B

COST MODEL - INPUT VARIABLES AND EQUATIONS

APPENDIX B

COST MODEL: DISCUSSION, ASSUMPTIONS AND LIMITATIONS

An economic analysis is a critical step in the design of training systems. A rational choice of an instructional delivery system cannot be based upon training effectiveness without regard to cost and vice versa. In order to facilitate the economic analysis of instructional systems, a cost model has been constructed. The model is simply a computational algorithm for determining both the cost of the components and the total instructional delivery system.

An economic analysis requires that alternatives be identified and associated resources specified. These determinations must be made prior to the use of the cost model and constitute the input data for the model. The TECEP approach outlined above provides a systematic procedure for the identification of feasible training systems and associated resource requirements. After alternatives have been identified and their resource requirements specified they must be "costed" and time phased. The most common method of costing is to place dollar values on the resources. These values can be time phased, discounted and summed to represent the present cost of each alternative.

The assumptions and objectives underlying the comparative costing of proposed media sets determines which resources are relevant and how these resources are valued. The interpretation of the output of the cost model is dependent upon these assumptions and objectives. For certain objectives the outputs have only relative meaning while for other applications the outputs could have absolute meaning.

When the objective of the analysis is to select the most efficient alternative from among a specified set, all of which are capable of meeting the training objectives, then the resources common to all alternatives can be factored out and ignored in the analysis. When the objective is to determine the total absolute long-run cost of training, then all resources used for training must be included and evaluated at their opportunity cost. When the objective is to determine the budget requirements to implement and operate a system, then the cost of resources which must be acquired plus the current costs of operation are the relevant costs.

In the use of the following cost model, the objectives of the analysis must be clearly specified and resources identified and priced accordingly. A meaningful economic analysis requires that alternatives be available, one of which may be the status quo. By making explicit all of the alternatives and their resource requirements, the analysis can often be greatly simplified. Resources which are common to all alternatives and difficult to evaluate can be factored out of the analysis.

Resources which are factored out are, nevertheless, a part of the total long-run cost of training. If the decision to undertake training is contingent upon the benefits to be acquired versus total training costs, then these resources must be evaluated and the total cost weighed against the benefits accruing from the training.

Most military tasks have become so sophisticated that the need for training is axiomatic. Often the pertinent question is how best to do the training and not whether or not to do the training. When the decision is already made to undertake the training to achieve a particular proficiency level then the benefits of any particular alternative over another can be measured with respect to the next most efficient alternative. Relative or incremental costing of alternatives provides sufficient information for selection of the more efficient alternatives.

It is anticipated that many users of the TECEP approach and the cost model will be administrators at the operational level. These individuals most often encounter problems of how best to provide a given level and quantity of training. They seldom have an opportunity to control these variables. Administrators at this level are most often faced with cost minimization problems and are primarily interested in planning their training system to most efficiently accomplish their training goals. They often have little need to determine the value or worth of training and, hence, have little need to compute a benefit-cost ratio.

While the emphasis of the TECEP approach is on cost minimization (fixed output levels) there will be requirements for analysis in which benefits fluctuate in response to training approaches. The evaluation of differential benefits accruing from different training approaches is a complex problem and one which has been beyond the objectives of this model. While the cost model can be used to evaluate the resources required for various training approaches, it does not, nor was it intended to, provide a method of assessing differential benefits or effects of alternative training approaches.

The basic output of the cost model is the present value (cost) of each alternative. Additional arithmetical computations are presented. The latter include the total and average annual cost per student position, the average cost per graduate and a distribution of the incidence of costs over the life of the alternative being evaluated.

For most applications of the model, the analysts will be required to access multiple data sources. Past records of operational units provide one valuable data source. Personnel data published by NAVPERS, and other similar types of data can be used for estimates of personnel costs. While the model requires rather detailed breakdown of certain data, the model can be used to advantage even when many of these data are not highly reliable. However, data reliability must be recognized in the interpretation of results.

There are numerous limitations in the use of the model. First, and perhaps most significant, the model is not capable of identifying or selecting (from among the feasible set) the most efficient media. The model does not utilize any optimization criteria for ascertaining effectiveness or efficiency. Its use is limited to a cost determination of proposed alternatives (media sets) and only through an iterative use of the model could one hope to move toward more efficient solutions. Furthermore, the model is not designed to predict or forecast the total cost of a system for which a planner must budget resources. Its primary purpose is to aid in selecting the most efficient instructional medium.

Second, the model is constructed upon the assumption that for any specified planning period there will be some resources which must be used as they exist and others which can be varied to accommodate various training numbers and levels. However, there is both an absolute limit and an efficient limit to the amount of variable resources which can be expanded against a fixed set of resources and one must be cognizant of these limitations in the use of the model.

A basic computational unit for which many of the variable costs are entered in the model is the "student position."[10] The number of student positions required, and hence the variable resources, are computed as a function of the training requirements. The training requirements are exogenously determined and reflect both numbers trained and course characteristics.

Changes in educational technology which have the effect of reducing the time required in the media may result in the need for fewer student positions and lower numbers of students in training to fulfill training requirements. These cost savings would be reflected in the model. The impact of introducing educational technology which has no effect on the resource requirements or time spent in training cannot be evaluated with this cost model. The model is not designed to evaluate the effects of introducing technology in which the impact occurs entirely on the benefit side.

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[10] A student position may be a carrel and related instructional material, a classroom position and related equipment, a flight simulator, or it might be uniquely defined in terms of the system being analyzed.

Third, the model assumes all variable cost functions are linear--an assumption that may not be tenable for specific training situations.

Fourth, the model does not provide any means for evaluation of secondary, or spillover, effects of alternative training approaches.[11] These effects are implicitly assumed to be constant (or equal) for alternatives considered. If such effects do in fact exist, they must be evaluated outside the model. A general model cannot be defined in sufficient detail to cover all possible contingencies. These contingencies may require the user to exercise judgment in his interpretation of input variables. The important consideration is that all relevant costs be included and that data are entered in the input variables in a manner which avoids double counting.

The user may often find it convenient to redefine certain variables in order to reduce the complexity of the input data for specific applications. Such changes can be made by identifying the relevant functional relationships in the FORTRAN program and making changes in these relationships where necessary.

If the analyst is willing to make certain assumptions about the structure of the cost data at various points throughout the model, then a number of the input variables are not relevant and can be entered as zero. For example, if the instructional material is developed prior to implementation and no further development is undertaken during the planning period then the variable concerning the dollars required for instructional material development is zero for all years in the planning period. Similarly, if it can be assumed that the instructional material has no remaining value at the end of the planning period, then the variable concerning the remaining value of instructional materials is equal to zero. A willingness to eliminate many of these factors by assumption would enable the analysts to reduce the complexity of the input data.

An effort was made in constructing the model to gain as much flexibility as possible, yet not at the expense of eliminating the model usefulness for analysis of less complex problems.

[11] Secondary effects are those effects which occur outside the influence of the decision-making unit. Therefore, the decision maker does not normally consider the impact of secondary effects when making his decision. However, from a societal viewpoint these effects may be extremely important. An example of a secondary effect, and one not normally considered in evaluating military training, is the worth of the training to the individual in preparing him for a civilian occupation.

The input variables are classified into seven classes as follows: (1) facilities, (2) equipment, (3) instructional material development, (4) personnel, (5) students, (6) supplies, and (7) miscellaneous. A definition of each variable follows:

1. Facilities

FACOST	Total costs of facilities acquisition and refurbishing which are necessary for implementation.
LOFFA	Expected years of life of FACOST assets.
CPSQFT(I)	The annual cost of operation and maintenance of facilities per square foot (includes operation, maintenance, janitorial service, utilities, etc.). Include the annual opportunity costs of facilities where applicable.
SQFTIN	Total square feet required for each instructor.
SQFTST	Total square feet required per student position.
SQFTAM	Total square feet required for administrative overhead.

2. Equipment

EQCISP	The cost of equipment necessary for implementation (that which is not dependent on the number of student positions). Do not include equipment which is uniquely associated with student positions (i.e., costs included in variable EQIMPC).
LOFEQ1	The expected years of life of equipment included in EQCISP.
CAQSP(I)	Total cost of equipment to be acquired in each year of planning period following implementation. Include cost of equipment which represents expansion or addition to the program plus replacement costs for that equipment included in EQCISP.
LOFEQ(I)	The expected years of life of equipment which has been included in CAQSP(I).

OMFEQ(I)	Total annual operation and maintenance cost of fixed equipment; i.e., the operation and maintenance cost of equipment not uniquely related to student positions. O&M costs of equipment included in variable EQCISP and CAQSP(I).
EQIMPC	The cost of equipment (per student position) which must be acquired for implementation. Do not include equipment which is not uniquely related to student positions (i.e., do not include equipment costs included in variable EQCISP).
LOFEQ	The expected years of life of student position equipment; i.e., equipment included in EQIMPC.
COPMT(I)	Annual operation, maintenance, and replacement costs of equipment associated with each student position in each year of the planning period; i.e., the O&M costs of equipment included in variable EQIMPC and the replacement costs of any student position related equipment.
TSPOSD	The percentage of planned operating time the student position equipment is nonfunctional because of unplanned contingencies; i.e., equipment failure, weather, etc. (percentage of down time equals one minus the percentage availability).

3. Instructional Material Development

UIMD	The percentage of time spent in the training medium (for the nonrecycled student) for which unique hours of instructional material must be developed.
UIMDYR(I)	The number of unique hours of new instructional material to be developed in each year of the planning period. (The model assumes that any materiel developed and reflected in this variable is unique to the course and will be fully depreciated at the end of the planning period.) This variable does not include any updating of original course material.

UPDATE	Update factor for instructional material. Percentage of the original development of instructional material expended each year to maintain the courseware.
EVIM	The percentage of the original development cost of the instructional material which remains at the end of the planning period.
CIMD	Average cost of developing the master copy for one hour of instruction (i.e., the per unit instructional material development costs).

4. Personnel

INTSPO	Instructor-to-student position ratio.
SALINR	Average annual salary and benefits for one instructor.

5. Supplies

SUPPLY	Average cost of expendable supplies per student while in the training medium.

6. Students

GRAD(I)	The number of students who must be trained for each year of the planning period; i.e., the number who must complete the program and graduate.
STUDSL	Average annual salary and benefits for one student.
STCST1	Average student travel costs to and from school. Do not include any travel done as part of the course.
STCST2	Average student travel costs which are incurred as part of the course. Do not include any costs to and from school.

7. Miscellaneous

N	The number of years in the planning period. (In setting the planning period, guidance can be found in SECNAVINST 7000.14A, pages 7 & 8.)

ARATE	The attrition rate. The percentage of students who enroll in the program but never complete the training.
DRATE	The discount rate (10 percent according to DoD Instruction 7041.3).
WSCHOP	The time in weeks the student position is available per year.
TLENGH	The average time in weeks spent in the training medium for the nonrecycled student.
TLEGTH	The average hours per week the student spends in the medium.
RCRATE	Recycle rate equals the percentage of students enrolling in the training who will repeat some part of the program.
ARCYTM	Average recycle time in weeks equals the average amount of time a student spends in repeating any and all parts of the course.
ESP	The percentage of student positions above the computed number which are to be acquired to provide for fluctuations in student inputs through the system.

The following variables are computed by the model from the above input data:

1. Facilities

TSQFT	Total square feet of facilities required: TSQFT=(SQFTST)(PSP)+(INTSPO)(PSP)(SQFTIN)+SQFTAM.
FCOST(I)	Total cost of facilities for each year of the planning period: FCOST(I)=(TSQFT)(CPSQFT(I)).

2. Equipment

NSPR(I)	Number of student positions required for the system:

$NSPR(I)=((SMWRRC(I)+STUDMW(I))/(WSCHOP)/(1-TSOPSD).$

MNSP	Mean number of student positions for planning period: $MNSP=\sum_{I=1}^{N} NSPR(I)/N.$
PSP	Planned number of student positions: $PSP=MNSP+(ESP)(MNSP).$
EAQCI	Equipment acquisition costs necessary for implementation: $EAQCI=(EQIMPC)(PSP)+(EQCISP).$
TAEQC(I)	Total annual operation, maintenance and equipment acquisition costs for each year of the planning period: $TAEQC(I)=(CAQSP(I)+(COPMT(I))(PSP)+OMFEQ(I).$
E_3	Annual depreciation of student position equipment: $E_3 = (EQIMPC)(PSP)/LOFEQ.$
R	Internal computed variable indicating the years of life remaining in equipment at end of planning period.
RVEQ	Remaining value of student position equipment at end of planning period: $RVEQ=(R)(E_3).$
RVEQ2	Remaining value of equipment purchased in each year of planning period (- for all $(LOFEQ(I) -N) \geq 0$): $RVEQ2=\sum_{I=1}^{N} (LOFEQ(I)-N) * (CAQSP(I)/LOFEQ(I)).$

RVEQ3	Remaining value of equipment purchased for implementation (-for all (LOFEQ1-N)≥ 0): RVEQ3 = (LOFEQ1-N) * EQCISP/LOFEQ1.

3. Instructional Material

ACIMD	Instructional material development costs for implementation: ACIMD=(CIMD)(UIMD)(TLEGTH)(TLENGH).
CUIMD(I)	Total cost of developing instructional material in each year of planning period: CUIMD(I)=(CIMD)(UIMDYR(I)).
AIMMC(I)	Maintenance costs of instructional material for each year of planning period: AIMMC(I)=CUIMD(I)+(ACIMD)(UPDATE).
RVIM	Remaining value of instructional material at end of planning period: RVIM=(ACIMD)(EVIM).

4. Personnel

RINSTR	Number of instructors required: RINSTR=(INTSPO)(PSP).
CINSTR(I)	Total costs of salary and benefits for all instructors for each year of planning period: CINSTR(I)=(SALINR)(RINSTR).

5. Students

STUD(I)	Student inputs necessary in each year to provide the required number of graduates: STUD(I)=GRAD(I)/(1-ARATE).

AASIN	Average annual student inputs required to provide the number of graduates specified in each year: $\mathrm{AASIN}=\sum_{I=1}^{N}\mathrm{STUD(I)/N.}$
STUDMW(I)	Total time required in training for all students in each year of planning period to train the required number of students (to specified objectives) utilizing the media set under consideration (exclude recycle time): $\mathrm{STUDMW(I)=(TLENGH)(STUD(I))(1-.5(ARATE)).}$
SMWRRC(I)	Total time required for recycling for all students in each year of planning period: $\mathrm{SMWRRC(I)=(RCRATE)(STUD(I))(ARCYTM).}$
AOB(I)	Average number of students on board for each year: $\mathrm{AOB(I)=(SMWRRC(I)+STUDMW(I))/WSCHOP.}$
AAOB	Mean number of students on board for entire planning period: $\mathrm{AAOB}=\sum_{I=1}^{N}\mathrm{AOB(I)/N.}$
TRAVEL	Total annual travel costs for all students: $\mathrm{TRAVEL=(AASIN)(STCST1)+(STCST2)(AASIN)(1-0.5\ ARATE).}$
SSALRY(I)	Total costs of student salary and benefits for all students for each year of planning period: $\mathrm{SSALRY(I)=((SMWRRC(I)+STUDMW(I))/52)(STUDSL).}$

6. Supplies

SUPPY(I)	Total cost of student supplies for each year in planning period: $\mathrm{SUPPY(I)=(STUD(I))(SUPPLY).}$

7. Miscellaneous

UDACST(I)	Total nondiscounted costs for each year in planning period: $\text{UDACST(I)}=\text{FCOST(I)}+\text{TAEQC(I)}+\text{AIMMC(I)}+\text{CINSTR(I)}+\text{SUPPY(I)}+\text{SSALRY(I)}+\text{TRAVEL}.$
H_4	Total nondiscounted cost of alternative: $H_4=\sum_{I=1}^{N}\text{UDACST(I)}+\text{FACOST}+\text{EAQCI}+\text{ACIMD}-\text{RVAS}/(1+\text{DRATE})^{N}.$
RVAS	Remaining value of equipment and instructional material at end of planning period: $\text{RVAS}=\text{RVEQ}+\text{RVIM}+\text{RVFA}$
PVALUE	Present value (cost) of alternative: $\text{PVALUE}=\sum_{I=1}^{N}((\text{UCACST(I)}(2+\text{DRATE}))/(2(1+\text{DRATE})^{I})+[\text{FACOST}+\text{EAQCI}+\text{ACIMD}]-[\text{RVAS}/(1.0+\text{DRATE})^{N}].$
C_3	Average discounted costs per student position: $C_3=\text{PVALUE}/\text{PSP}$
CINT	Initial system acquisition costs for facilities, equipment, and instructional material development: $\text{CINT}=\text{FACOST}+\text{EQACI}+\text{ACIMD}.$
ANCSP	Average annual nondiscounted costs per student position. $\text{ANCSP}=H_4/(\text{N})(\text{PSP})$
ADCSP	Average annual discounted costs per student position: $\text{ADCSP}=\text{PVALUE}/(\text{N})(\text{PSP})$

ACSP	Initial system acquisition costs for facilities, equipment, and instructional material development per student position: $ACSP=CINT/PSP.$
UAC	Uniform annual costs: $UAC=PVALUE/\sum_{I=1}^{N}\left[(2+DRATE)/(2(1+DRATE)^{I})\right].$

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APPENDIX C

FORTRAN PROGRAM OF COST MODEL

APPENDIX C

FORTRAN PROGRAM OF COST MODEL

The purpose of this appendix is to supply the necessary information for the use of the FORTRAN IV Cost Model program. This information includes a FORTRAN IV Program Listing, a sample data set and a sample run. The data collection sheets which define the program's input variables are presented as attachment 1 following this appendix.

The data are entered into the computer using an "F" format. All fields are eight columns wide. This format allows the data to be easily keypunched directly from the data collection sheets. A sample set of data cards is shown in the data deck listing following the program listing. Table 17 defines the fields on the first group of data cards. Each numeric field must contain a decimal point or else it will be interpreted as having two digits to the right of the decimal point.

Several output options are available to the user of the cost model program. The user may select all of the printouts shown in figures 7, 9, and 10, or he may choose any combination thereof. A "1" punched in the appropriate column of card one selects the desired printout. If the user desires these tables, he must supply the appropriate cards to define the variable portions of the tables. Figure 7 requires five cards per delivery system media to define the righthand side of the table. The user must provide a card to define the top row of figure 10 as well as the cards necessary to define the righthand column of the table. Each table can contain up to 15 rows. The data deck listing shows the cards used to generate the tables in this document.

Figure 7 always displays the same eight output variables. Note that the rows of numbers for this table are printed in the same sequence as they are calculated. Therefore, the row identification label cards must be in the same order. Figure 10 allows the user to select one of 20 output variables and display the value of this variable for up to eight categories of training, such as procedure following or decision making computed on up to 120 previous runs. A particular run's position in the table is determined by the numbers on the Run ID card. For example, the "2" and "6" on the Run ID card for Example 2 specifies that this run is to occupy row 2, column 6 of the table. The variable to be displayed in figure 10 is selected by punching the appropriate number on a title card. The output variables are considered to be numbered from 1 to 20 as they appear on the printout shown in figure 9. For example, Average Annual Student Input is variable number 1, while Nondiscounted Cost of Alternative is variable number 4. Table 18 defines the card columns of the cards used to generate figure 10. These cards are the last group of cards shown in the data deck listing. The subroutine that prints figure 10 will continue to read title and variable selection cards until an end of file is encountered.

TABLE 17. CARD AND COLUMN DEFINITIONS (CARDS 1-6) FOR COST MODEL INPUT

Card 1
Column 1- =1 - Print all input and output variables
Column 2- =2 - Print table shown in figure 7
Column 3- =1 - Print table shown in figure 10

Card 2
Columns 1-72 - Up to 72 alphanumeric characters
Columns 73-76 - Media number
Columns 77-80 - Learning category number

Card 3
Columns 1-80 - Up to 80 alphanumeric characters

Card 4
Columns 1-8 - FACOST
" 9-16 - LOFFA
" 17-24 - SQFTIN
" 25-32 - SQFTST

" 33-40 - SQFTAM
" 41-48 - EQCISP
" 49-56 - LOFEQ1
" 57-64 - EQIMPC
" 65-72 - LOFEQ
" 73-80 - TSPOSD

Card 5
Columns 1-8 - UIMD
" 9-16 - UPDATE
" 17-24 - EVIM
" 25-32 - CIMD
" 33-40 - INTSPO
" 41-48 - SALINR
" 49-56 - SUPPLY
" 57-64 - STUDSL
" 65-72 - STCST1
" 73-80 - STCST2

TABLE 17. CARD AND COLUMN DEFINITIONS (CARDS 6-10) FOR COST MODEL INPUT (continued)

Card 6
Columns 1-8 - N
" 9-16 - ARATE
" 17-24 - DRATE
" 25-32 - WSCHOP
" 33-40 - TLENGH
" 41-48 - TLEGTH
" 49-56 - RCRATE
" 57-64 - ARCYTM
" 65-72 - ESP
" 73-80 -

Card 7*
Columns 1-8 - CPSQFT(1) Year 1
" 9-16 - CPSQFT(2) Year 2
. . .
. . .
. . .
" 73-80 - CPSQFT(10) Year 10

Card 8*
Columns 1-8 - CAQSP(1) Year 1
" 9-16 - CAQSP(2) Year 2
. . .
. . .
. . .
" 73-80 - CAQSP(10) Year 10

Card 9*
Columns 1-8 - LOFEQ(1) Year 1
" 9-16 - LOFEQ(2) Year 2
. . .
. . .
. . .
" 73-80 - LOFEQ(10) Year 10

Card 10*
Columns 1-8 - COPMT(1) Year 1
" 9-16 - COPMT(2) Year 2
. . .
. . .
. . .
" 73-80 - COPMT(10) Year 10

* A separate card is required for each ten values or fraction thereof.

TABLE 17. CARD AND COLUMN DEFINITIONS (CARDS 11-13) FOR COST MODEL INPUT (continued)

Card 11*			
Columns	1-8	- OMFEQ(1)	Year 1
"	9-16	- OMFEQ(2)	Year 2
	.	.	.
	.	.	.
	.	.	.
"	73-80	- OMFEQ(10)	Year 10
Card 12*			
Columns	1-8	- GRAD(1)	Year 1
"	9-16	- GRAD(2)	Year 2
	.	.	.
	.	.	.
	.	.	.
"	73-80	- GRAD(10)	Year 10
Card 13*			
Columns	1-8	- UIMDYR(1)	Year 1
"	9-16	- UIMDYR(2)	Year 2
	.	.	.
	.	.	.
	.	.	.
"	73-80	- UIMDYR(10)	Year 10

* A separate card is required for each ten values or fraction thereof.

TABLE 18. CARDS FOR GENERATING FIGURE 10

Card 1 - Column headings

Columns 1-8 - Heading for table column 1
" 9-16 - " " " " 2
" 17-24 - " " " " 3
" 25-32 - " " " " 4
" 33-40 - " " " " 5
" 41-48 - " " " " 6
" 49-56 - " " " " 7
" 57-64 - " " " " 8
" 73-74 - Number of row label cards

Card 2 - Row labels*

Columns 1-16 - Label for row 1
" 17-32 - " " " 2
" 33-48 - " " " 3
" 49-64 - " " " 4
" 65-80 - " " " 5

Card 3 - Title and variable selection card

Columns 1-76 - Title of table
" 77-78 - Variable selection number (1-20)
" 79-80 - The number of rows to be printed

* A label card is necessary for every five rows or fraction thereof.

```
                                                          INPUT DATA
RUN ID : EXAMPLE 1
INSTRUCTIONAL DELIVERY SYSTEM - OPERATIONAL SYSTEM IN A LABORATORY WITH TUTOR
YEAR                                          1         2         3         4         5         6         7         8         9

GRADUATES REQD./YEAR                     1300.0    1400.0    1300.0    1200.0    1200.0    1100.0    1100.0    1100.0    1100.0
COST/SQ FT.                                2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75
OPERATION AND MAINT. COST/YR.            150.00    150.00    150.00    150.00    150.00    150.00    150.00    150.00    150.00
O&M COST OF FIXED EQUIPMENT                0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
ANNUAL ACQUISTION COST/STUD. POS           0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
EXPECTED LIFE OF CAQSP(I) ASSETS            0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
UNIQUE HOURS OF IMD/YR                      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0


YEAR                                         10

GRADUATES REQD./YEAR                     1100.0
COST/SQ FT.                                2.75
OPERATION AND MAINT. COST/YR.            150.00
O&M COST OF FIXED EQUIPMENT                0.00
ANNUAL ACQUISTION COST/STUD. POS           0.00
EXPECTED LIFE OF CAQSP(I) ASSETS            0.0
UNIQUE HOURS OF IMD/YR                      0.0


NO. OF YEARS IN PLANNING PERIOD              10
FACILITIES ACQUISTION OR REFURBISH COST    0.00
EXPECTED LIFE OF FACILITIES (YEARS)        0.00
SQ FT/INSTR. POS.                          64.0
SQ FT/STUDENT POS.                         75.0
TOTAL SQ FT REQUIRED FOR ADMIN OVERHEAD  100.00
EQUIP. IMPLEM. COST INDEPEND. STUD POS     0.00
LIFE OF IMPLEMENTATION EQUIPMENT           0.00
EQUIPMENT IMPLEMENTATION COST/STUD POS  3000.00
LIFE OF STUD POS EQUIP                     10.0
TIME STUDENT POS ARE DOWN                  0.01
PER CENT OF TRAINING MEDIUM TIME
REQUIRING UNIQUE HOURS OF IMD              1.00
UPDATE FACTOR                              0.20
VALUE OF IM AT END OF PLANNING PER.        0.00
HOURLY COST OF IMD                        30.00
INSTR./STUDENT POS. RATIO                 1.000
SALARY OF ONE INSTR.                   16240.00
SUPPLIES COST/STUDENT                      0.00
STUDENT SALARY                         11141.00
AVE. STUDENT TRAVEL COST TO/FROM SCH       0.00
AVE. STUDENT TRAVEL AS A PART OF COURSE    0.00
ATTRITION RATE                             0.04
DISCOUNT RATE                              0.10
WEEKS SCHOOL OPERATES/YR                   50.0
LENGTH OF TRAINING IN WKS.                 0.10
AVE. HRS/WK. SPENT IN TRAINING MEDIUM       3.0
RECYCLE RATE                               0.00
AVE. RECYCLE TIME IN WKS                   0.00
EXCESS NO. OF STUDENT POSITIONS            0.05
```

Figure 9. Sample Cost Model Output for Specific Delivery Systems

```
RUN ID : EXAMPLE 1
INSTRUCTIONAL DELIVERY SYSTEM - OPERATIONAL SYSTEM IN A LABORATORY WITH TUTOR

                                                OUTPUT SUMMARY YEARS 1- 9
YEAR                                        1         2         3         4         5         6         7         8         9

STUDENT INPUT                          1354.2    1458.3    1354.2    1250.0    1250.0    1145.8    1145.8    1145.8    1145.8
AVE. NO. OF STUDENTS ON BOARD             2.7       2.9       2.7       2.4       2.4       2.2       2.2       2.2       2.2
NONDISCOUNTED ANNUAL FAC. COST          1260.     1260.     1260.     1260.     1260.     1260.     1260.     1260.     1260.
NONDISCOUNTED ANNUAL EQUIPMENT COST     386.5     386.5     386.5     386.5     386.5     386.5     386.5     386.5     386.5
NONDISCOUNTED ANNUAL IM COST              1.8       1.8       1.8       1.8       1.8       1.8       1.8       1.8       1.8
NONDISCOUNTED ANNUAL INSTR. COST      41847.7   41847.7   41847.7   41847.7   41847.7   41847.7   41847.7   41847.7   41847.7
NONDISCOUNTED ANNUAL SUPPLY COST          0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
NONDISCOUNTED ANNUAL STUDENT SALARIES 28432.8   30619.9   28432.8   26245.6   26245.6   24058.5   24058.5   24058.5   24058.5
NONDISCOUNTED ANNUAL TRAVEL COST          0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
NONDISCOUNTED ANNUAL OPERATION COST   71928.7   74115.8   71928.7   69741.6   69741.6   67554.4   67554.4   67554.4   67554.4


                                                OUTPUT SUMMARY YEARS10-10
YEAR                                       10

STUDENT INPUT                          1145.8
AVE. NO. OF STUDENTS ON BOARD             2.2
NONDISCOUNTED ANNUAL FAC. COST          1260.
NONDISCOUNTED ANNUAL EQUIPMENT COST     386.5
NONDISCOUNTED ANNUAL IM COST              1.8
NONDISCOUNTED ANNUAL INSTR. COST      41847.7
NONDISCOUNTED ANNUAL SUPPLY COST          0.0
NONDISCOUNTED ANNUAL STUDENT SALARIES 24058.5
NONDISCOUNTED ANNUAL TRAVEL COST          0.0
NONDISCOUNTED ANNUAL OPERATION COST   67554.4



AVE. ANNUAL STUDENT INPUT                  1239.58
AVE. ANNUAL NO. OF STUDENTS ON BOARD          2.43
PRESENT COST OF ALTERNATIVE              459902.63
NONDISCOUNTED COST OF ALTERNATIVE        702967.94
AVE. DISCOUNTED COST/GRADUATE                38.65
NONDISCOUNTED COST/GRADUATE                  59.07
AVE. DISCOUNTED COST/STUDENT POSITION    178476.38
INITIAL EQUIPMENT ACQUISTION COST          7730.48
INITIAL FACILITIES ACQUISITION COST           0.00
INITIAL IM DEV COST                           9.00
INITIAL SYSTEM ACQUISTION COST
FOR FACILITIES.EQUIP,AND IMD               7739.48
REMAINING VALUE OF EQUIPMENT                  0.00
REMAINING VALUE OF IM                         0.00
NO. OF INSTRUCTORS REQUIRED                   2.58
NO. OF STUDENT POSITIONS                      2.45
FACILITY REQUIREMENTS IN SQ FT              458.18
AVE. ANNUAL NONDIS. COST/STUD POS         27280.39
AVE. ANNUAL DISCOUNTED COST/STUD POS      17847.04
ACQUISTITION COST/STUD POS                 3003.49
UNIFORM ANNUAL COST                       71262.63
```

Figure 9. Sample Cost Model Output for Specific Delivery Systems (continued)

```
                                                          INPUT DATA
RUN ID : EXAMPLE 2
INSTRUCTIONAL DELIVERY SYSTEM - MICROFISHE WITH PHOTO MOCKUP
YEAR                                         1         2         3         4         5         6         7         8         9

GRADUATES REQD./YEAR                    1300.0    1400.0    1300.0    1200.0    1200.0    1100.0    1100.0    1100.0    1100.0
COST/SQ FT.                               2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75
OPERATION AND MAINT. COST/YR.            15.00     15.00     15.00     15.00     15.00     15.00     15.00     15.00     15.00
O&M COST OF FIXED EQUIPMENT               0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
ANNUAL ACQUISTION COST/STUD. POS          0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
EXPECTED LIFE OF CAQSP(I) ASSETS           0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
UNIQUE HOURS OF IMD/YR                     0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0


YEAR                                        10

GRADUATES REQD./YEAR                    1100.0
COST/SQ FT.                               2.75
OPERATION AND MAINT. COST/YR.            15.00
O&M COST OF FIXED EQUIPMENT               0.00
ANNUAL ACQUISTION COST/STUD. POS          0.00
EXPECTED LIFE OF CAQSP(I) ASSETS           0.0
UNIQUE HOURS OF IMD/YR                     0.0


NO. OF YEARS IN PLANNING PERIOD             10
FACILITIES ACQUISTION OR REFURBISH COST   0.00
EXPECTED LIFE OF FACILITIES (YEARS)       0.00
SQ FT/INSTR. POS.                         64.0
SQ FT/STUDENT POS.                        75.0
TOTAL SQ FT REQUIRED FOR ADMIN OVERHEAD 100.00
EQUIP. IMPLEM. COST INDEPEND. STUD POS    0.00
LIFE OF IMPLEMENTATION EQUIPMENT          0.00
EQUIPMENT IMPLEMENTATION COST/STUD POS  275.00
LIFE OF STUD POS EQUIP                    10.0
TIME STUDENT POS ARE DOWN                 0.01
PER CENT OF TRAINING MEDIUM TIME
REQUIRING UNIQUE HOURS OF IMD             1.00
UPDATE FACTOR                             0.20
VALUE OF IM AT END OF PLANNING PER.       0.00
HOURLY COST OF IMD                     1134.00
INSTR./STUDENT POS. RATIO                0.100
SALARY OF ONE INSTR.                  16240.00
SUPPLIES COST/STUDENT                     0.00
STUDENT SALARY                        11141.00
AVE. STUDENT TRAVEL COST TO/FROM SCH      0.00
AVE. STUDENT TRAVEL AS A PART OF COURSE   0.00
ATTRITION RATE                            0.04
DISCOUNT RATE                             0.10
WEEKS SCHOOL OPERATES/YR                  50.0
LENGTH OF TRAINING IN WKS.                0.10
AVE. HRS/WK. SPENT IN TRAINING MEDIUM      4.0
RECYCLE RATE                              0.05
AVE. RECYCLE TIME IN WKS                  0.10
EXCESS NO. OF STUDENT POSITIONS           0.05
```

Figure 9. Sample Cost Model Output for Specific Delivery Systems (continued)

```
RUN ID : EXAMPLE 2
INSTRUCTIONAL DELIVERY SYSTEM - MICROFISHE WITH PHOTO MOCKUP

                                           OUTPUT SUMMARY YEARS 1- 9
YEAR                                         1         2         3         4         5         6         7         8         9

STUDENT INPUT                             1354.2    1458.3    1354.2    1250.0    1250.0    1145.8    1145.8    1145.8    1145.8
AVE. NO. OF STUDENTS ON BOARD                2.8       3.0       2.8       2.6       2.6       2.4       2.4       2.4       2.4
NONDISCOUNTED ANNUAL FAC. COST              881.      881.      881.      881.      881.      881.      881.      881.      881.
NONDISCOUNTED ANNUAL EQUIPMENT COST         40.6      40.6      40.6      40.6      40.6      40.6      40.6      40.6      40.6
NONDISCOUNTED ANNUAL IM COST                90.7      90.7      90.7      90.7      90.7      90.7      90.7      90.7      90.7
NONDISCOUNTED ANNUAL INSTR. COST          4398.3    4398.3    4398.3    4398.3    4398.3    4398.3    4398.3    4398.3    4398.3
NONDISCOUNTED ANNUAL SUPPLY COST             0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
NONDISCOUNTED ANNUAL STUDENT SALARIES    29883.4   32192.1   29883.4   27584.7   27584.7   25285.9   25285.9   25285.9   25285.9
NONDISCOUNTED ANNUAL TRAVEL COST             0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
NONDISCOUNTED ANNUAL OPERATION COST      35294.3   37593.0   35294.3   32995.5   32995.5   30696.8   30696.8   30696.8   30696.8


                                           OUTPUT SUMMARY YEARS10-10
YEAR                                        10

STUDENT INPUT                             1145.8
AVE. NO. OF STUDENTS ON BOARD                2.4
NONDISCOUNTED ANNUAL FAC. COST              881.
NONDISCOUNTED ANNUAL EQUIPMENT COST         40.6
NONDISCOUNTED ANNUAL IM COST                90.7
NONDISCOUNTED ANNUAL INSTR. COST          4398.3
NONDISCOUNTED ANNUAL SUPPLY COST             0.0
NONDISCOUNTED ANNUAL STUDENT SALARIES    25285.9
NONDISCOUNTED ANNUAL TRAVEL COST             0.0
NONDISCOUNTED ANNUAL OPERATION COST      30696.8



AVE. ANNUAL STUDENT INPUT                1239.58
AVE. ANNUAL NO. OF STUDENTS ON BOARD        2.55
PRESENT COST OF ALTERNATIVE            216395.19
NONDISCOUNTED COST OF ALTERNATIVE      328854.08
AVE. DISCOUNTED COST/GRADUATE              18.14
NONDISCOUNTED COST/GRADUATE                27.63
AVE. DISCOUNTED COST/STUDENT POSITION   79900.88
INITIAL EQUIPMENT ACQUISTION COST         744.78
INITIAL FACILITIES ACQUISTION COST          0.00
INITIAL IM DEV COST                       453.60
INITIAL SYSTEM ACQUISTION COST
FOR FACILITIES,EQUIP,AND IMD             1198.38
REMAINING VALUE OF EQUIPMENT                0.00
REMAINING VALUE OF IM                       0.00
NO. OF INSTRUCTORS REQUIRED                 0.27
NO. OF STUDENT POSITIONS                    2.58
FACILITY REQUIREMENTS IN SQ FT            320.46
AVE. ANNUAL NONDIS. COST/STUD POS       12142.50
AVE. ANNUAL DISCOUNTED COST/STUD POS     7990.09
ACQUISTIION COST/STUD POS                 442.49
UNIFORM ANNUAL COST                     33540.19
```

Figure 9. Sample Cost Model Output for Specific Delivery Systems (continued)

```
NONDISCOUNTED COST PER GRADUATE - EXAMPLE 1

*******************************************************************************************************************
*                  *  CAT 1    *  CAT 2    *  CAT 3    *  CAT 4    *  CAT 5    *  CAT 6    *  CAT 7    *  CAT 8    *
*******************************************************************************************************************
*   OP. SYSTEM     *      59.1 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *
*******************************************************************************************************************
*   MICROFICHE     *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *      27.6 *       0.0 *       0.0 *
*******************************************************************************************************************
*      CAI         *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *
*******************************************************************************************************************

NONDISCOUNTED COST OF ALTERNATIVE

*******************************************************************************************************************
*                  *  CAT 1    *  CAT 2    *  CAT 3    *  CAT 4    *  CAT 5    *  CAT 6    *  CAT 7    *  CAT 8    *
*******************************************************************************************************************
*   OP. SYSTEM     *  702947.9 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *
*******************************************************************************************************************
*   MICROFICHE     *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *  320854.9 *       0.0 *       0.0 *
*******************************************************************************************************************
*      CAI         *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *
*******************************************************************************************************************

INITIAL INSTRUCTIONAL MATERIAL DEVELOPMENT COST

*******************************************************************************************************************
*                  *  CAT 1    *  CAT 2    *  CAT 3    *  CAT 4    *  CAT 5    *  CAT 6    *  CAT 7    *  CAT 8    *
*******************************************************************************************************************
*   OP. SYSTEM     *       9.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *       0.0 *
```

Figure 10. Sample Summary Cost Data by Category of Training and Cost Factor

```
A FORTRAN IV (VER S43) SOURCE LISTING:                              04/10/75     PAGE  0001

      PROGRAM DTE001
C     ****************************************************************
C     *               PROGRAM - TECEPT      VERSION 1                *
C     *               PROGRAMMER - BILL PARRISH                      *
C     *               DATE - 12/2/74                                 *
C     *                                                              *
C     ****************************************************************
C
      REAL NSPR,LOFEQ                                                   00000750
      DIMENSION STUDMW(30),SMWRKC(30),NSPR(30),CUIMD(30)                00000800
      DIMENSION ALPHA1(20),ALPHA2(20),KEY(3)
      INTEGER R
      COMMON/INVAR/GRAD(30),CPSQFT(30),COPMT(30),CAQSP(30),UIMDYR(30),OM
     1FEQ(30),RLOFFQ(30)
      REAL NDCGRD,MNSP,INTSPD
      COMMON STUD(30),FCOST(30),TAFQC(30),AIMMC(30),CINSTR(30),SUPPY(30)
     1,SSALRY(30),UDACST(30),T(30),NUM(30),AOB(30)                      00001500
      COMMON /TVAR/ X(15,8,20)
      COMMON /DVAR/ AASIM,AAOB,PVALUE,H4,C1,NDCGRD,C3,FAOCI,FACOST,
     1ACTMD,CINT,RVEC,RVIM,RINSTR,MNSP,TSQFT,ANCSP,ADCSP,ACSP,UAC
      COMMON /TABLE/ TDATA(15,8)
C
C     DETERMINE DESIRED PRINTOUT
C
    3 READ(5,14,END=998) (KEY(I),I=1,3)
      DO 1 I=1,15
      DO 1 J=1,8
      DO 1 K=1,20
    1 X(I,J,K)=0.
      NRUN=0
C                                                                       00001690
C     READ INPUT DATA                                                   00001700
C                                                                       00001710
  200 READ(5,13,END=999) (ALPHA1(I),I=1,18),MED,LC
      READ(5,12) (ALPHA2(I),I=1,20)                                     00002200
      READ(5,5) FACOST,RLOFFA,SQFTIN,SQFTST,SQFTAM,EQCISP,RLOFQ1,EQIMPC,
     1LOFEQ,TSPOSD
      READ(5,5) UIMD,UPDATE,EVIM,CIMD,INTSPD,SALINR,SUPPCY,STUDSL,STCST1
     1,STCST2
      READ(5,5) RN,ARATE,DRATE,WSCHOP,TLENGH,TLEGTH,RCRATE,ARCYTM,ESP
      N=RN
      READ(5,5) (CPSQFT(I),I=1,N)
      READ(5,5) (CAQSP(I),I=1,N)
      READ(5,5) (RLOFEQ(I),I=1,N)
      READ(5,5) (COPMT(I),I=1,N)
      READ(5,5) (OMFEQ(I),I=1,N)
      READ(5,5) (GRAD(I),I=1,N)
      READ(5,5) (UIMDYR(I),I=1,N)
C                                                                       00002850
C     PROGRAM INITIALIZATION
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTE001 PROGRAM        04/10/75     PAGE  0002
   C                                                                        00002950
          DO 2 I=1,N
        2 NUM(I)=I
          AASIN =0.0
          MNSP =0.0
          AAOB =0.0                                                         00003350
          PVALUE =0.0
          G2 =0.0
          NDCGRD =0.0
          DRAT=0.
   C                                                                        00003650
   C      MODEL EQUATIONS
   C                                                                        00003750
          ACIMD=CIMD*UIMD*TLEGTH*TLENGH
          DO 300 I=1,N
          STUD(I) = GRAD(I)/(1.0-ARATE)
      300 AASIN =AASIN + STUD(I)
          AASIN =AASIN/N
          TRAVEL =ASSIN*STCST1 +AASIN*STCST2*(1.0-0.5*ARATE)
          DO 310 I=1,N
          STUDMW(I) =TLENGH * STUD(I) *(1.0-0.5*ARATE)
          SMWRRC(I) =RCRATE * STUD(I) * ARCYTM
          NSPR(I)=((SMWRRC(I)+STUDMW(I))/WSCHOP)/(1.0-TSPORD)                00004700
          AOB(I) = (SMWRRC(I)+STUDMW(I))/WSCHOP                              00004750
          AAOB = AAOB + AOB(I)                                               00004760
      310 MNSP= MNSP + NSPR(I)                                               00004800
          MNSP = MNSP/N
          AAOB = AAOB/N                                                      00004950
          PSP =MNSP +ESP*MNSP
          TSOFT =PSP*(SQFTST + INTSFD* SQFTIN)+ SQFTAM
          FAOCI =EQIMPC * PSP + EQCISP
          DO 340 I=1,N
          FCOST(I)= TSOFT * CPSQFT(I)
          TAFQC(I)= PSP * CUPMT(I)+ CAOSP(I)+ OMFEQ(I)
          CUIMD(I)=CIMD * UIMDYR(I)
          F4 = UPDATE * ACIMD
          AIMMC(I)=CUIMD(I) + F4
          RINSTR = INTSPD *PSP
          CINSTR(I) =RINSTR * SALINR
          SUPPY(I)  =STUD(I)* SUPPLY
          SSALRY(I) =((SMWRRC(I)+ STUDMW(I))/52.0)* STUDSL
          UDACST(I) =FCOST(I) + TAFQC(I) + AIMMC(I) + CINSTR(I) + SUPPY(I) +
         1SSALRY(I) + TRAVEL
          PVALUE=PVALUE +((UDACST(I)*(2.0+DRATE))/(2.0*(1.0+ DRATE)**I))
          G2 =G2 + GRAD(I)
      340 NDCGRD = NDCGRD +UDACST(I)
          F3=(EQIMPC * PSP)/LOFEQ
          I=1
          M7= LOFEQ
      400 I=I+1
```

```
A FORTRAN IV (VER S43) SOURCE LISTING:  DTE001  PROGRAM        04/10/75     PAGE  0003

      R=M7-N
      IF (R.GE.0) GO TO 401
      M7=I*M7
      GO TO 400
  401 RVEQ = R* E3
      RVEQ2=0.
      DO 30 I=1,N
      ILOFEQ=RLOFEQ(I)
      IF(ILOFEQ.LE.N) GO TO 30
      ANDP=CAQSV(I)/RLOFEQ(I)
      RVEQ2=RVEQ2+ (ILOFEQ-N) * ANDP
   30 CONTINUE
      RVFA=0.
      LOFFA=RLOFFA
      IF(LOFFA.LE.N) GO TO 35
      RFVA=(LOFFA-N)*(FACOST/LOFFA)
   35 RVEQ3=0.
      LOFEQ1=RLOFQ1
      IF(LOFEQ1.LE.N) GO TO 36
      ANDP1=EQCISP/LOFEQ1
      RVEQ3=(LOFEQ1-N)*ANDP1
   36 RVEQ=RVEQ+ RVEQ2+ RVEQ3
      RVIM = ACIMD * EVIM
      RVAS = RVEQ+ RVIM+RVFA
      PVALUE = PVALUE -(RVAS/(1.0+DRATE)**N) +FACOST +EAQCI +ACIMD
      C1 = PVALUE/G2
      H4 = NDCGRD-(RVAS/(1.0+DRATE)**N)+ FACOST +EAQCI +ACIMD
      NDCGRD =H4/G2
      C3= PVALUE/PSP
      ANCSP=H4/(PSP*N)
      ADCSP=PVALUE/(PSP*N)
      CINT = FACOST + EAQCI + ACIMD
      ACSP = CINT/PSP
      DO 40 I=1,N
   40 DRAT=DRAT+ ((2.0+DRATE)/(2.0*((1.0+DRATE)**I)))
      UAC= PVALUE/DRAT
      DO 750 J=1,N
  750 T(J)= TRAVEL
      IF(KEY(1).NE.1) GO TO 752
C     PRINT INPUT DATA
      WRITE(6,80)
      WRITE(6,10) (ALPHA1(I),I=1,20)                                    00010900
      WRITE(6,10) (ALPHA2(I),I=1,20)                                    00011000
C
C     PRINT INPUT ARRAYS
C                                                                       00009750
      IF (N.LE.9) M=N
      IF (N.GT.9) M=9
      L=1
      CALL DTEOA1(L,M,NUM)
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTE001  PROGRAM        04/10/75     PAGE  0004

      IF (N.LE.9) GO TO 510
      IF(N.LE.18) M=N
      IF(N.GT.18) M=18
      L=10
      CALL DTEOA1(L,M,NUM)
      IF(N.LE.18) GO TO 510
      M=N
      L=19
      CALL DTEOA1(L,M,NUM)
  510 WRITE(6,90) N
      WRITE(6,113) FACOST
      WRITE(6,117)  RLOFFA
      WRITE(6,101) SOFTIN
      WRITE(6,102) SOFTST
      WRITE(6,118) SOFTAM
      WRITE(6,112) EOCISP
      WRITE(6,116) RLOFQ1
      WRITE(6,111) EOIMPC
      WRITE(6,107) LOFFQ
      WRITE(6,94) TSPUSD
      WRITE(6,114) UIMP
      WRITE(6,103) UPDATE
      WRITE(6,108) EVIM
      WRITE(6,104) CIMP
      WRITE(6,100) INTSPT
      WRITE(6,105) SALINP
      WRITE(6,106) SUPPLY
      WRITE(6,109) STUDSL
      WRITE(6,97) STCST1
      WRITE(6,98) STCST2
      WRITE(6,91) ARATE
      WRITE(6,110) DRATE
      WRITE(6,93) WSCHOP
      WRITE(6,92) TLENGH
      WRITE(6,115) TLEGTH                                               00013150
      WRITE(6,95) RCRATE
      WRITE(6,96) ARCYTM
      WRITE (6,99) ESP
C
C     PRINT OUTPUT ARRAYS
C
  500 IF (N.LT.10) M=N
      IF (N.GE.10) M=9
      L=1
      K=6
      WRITE(K,11)
      WRITE(K,10) (ALPHA1(I),I=1,20)                                    00015600
      WRITE(K,10) (ALPHA2(I),I=1,20)                                    00015700
      CALL DTEOB1(L,M)
      IF (N.LE.9) GO TO 751
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTE001  PROGRAM        04/10/75     PAGE  0005

          IF(N.LE.18) M=N
          IF(N.GT.18) M=18
          L=1
          CALL DTE0B1(L,M)
          IF(N.LE.18) GO TO 751
          L=19
          M=N
          CALL DTE0B1(L,M)
C
C         PRINT OUTPUT SUMMARY
C
      751 IF(N.GT.18) WRITE(K,11)
          WRITE(K,711) AASIN
          WRITE(K,729) AADR                                                  00016700
          WRITE(K,712) PVALUE                                                00016800
          WRITE(K,713) H4                                                    00016900
          WRITE(K,714) C1                                                    00017000
          WRITE(K,715) NOCARD
          WRITE(K,716) C3                                                    00017200
          WRITE(K,717) EAQFI
          WRITE(K,718) FACOST
          WRITE(K,719) ACIMD
          WRITE(K,720) CINT                                                  00017600
          WRITE(K,721) RVEQ                                                  00017700
          WRITE(K,722) RVIM                                                  00017800
          WRITE(K,723) RINSTR
          WRITE(K,724) MNSP
          WRITE(K,725) TSQFT                                                 00018100
          WRITE(K,726) AHCSP
          WRITE(K,727) AMCSP                                                 00018300
          WRITE(K,728) ACSP
          WRITE(6,731) UAC
      752 IF(KEY(2).NE.1) GO TO 753
          NRUN=NRUN+1
          TDATA(NRUN,1)=PVALUE
          TDATA(NRUN,2)=C1
          TDATA(NRUN,3)=UAC
          TDATA(NRUN,4)=CINT
          TDATA(NRUN,5)=RINSTR
          TDATA(NRUN,6)=CINSTR(1)
          TDATA(NRUN,7)=MNSP
          TDATA(NRUN,8)=TLEGTH
      753 IF(KEY(3).EQ.1) CALL DTE0D1(MED,LC)
          GO TO 200                                                          00018500
      990 IF(KEY(2).EQ.1) CALL DTE0C1(NRUN)
          IF(KEY(3).EQ.1) CALL DTE0E1
          GO TO 3
      999 STOP
        5 FORMAT(10F8.2)
       10 FORMAT(1H ,20A4)                                                   00018900
```

```
A FORTRAN IV (VER 543) SOURCE LISTING:  DTE001  PROGRAM         04/10/75      PAGE  0006
      11 FORMAT (1H1)
      12 FORMAT(20A4)                                                   00019050
      13 FORMAT(18A4,2I4)
      14 FORMAT(3I1)
      60 FORMAT(1H1,60X,'INPUT DATA')
      90 FORMAT(1X,'NO. OF YEARS IN PLANNING PERIOD',9X,I10)
      91 FORMAT(' ATTRITION RATE',26X,F10.2)
      92 FORMAT(' LENGTH OF TRAINING IN WKS.',14X,F10.2)                00019500
      93 FORMAT(' WEEKS SCHOOL OPERATES/YR',16X,F10.1)
      94 FORMAT(' TIME STUDENT POS ARE DOWN',15X,F10.2)                 00019700
      95 FORMAT(' RECYCLE RATE ',27X,F10.2)                             00019800
      96 FORMAT(' AVE. RECYCLE TIME IN WKS',16X,F10.2)                  00019900
      97 FORMAT(' AVE. STUDENT TRAVEL COST TO/FROM SCH',4X,F10.2)
      98 FORMAT(' AVE. STUDENT TRAVEL AS A PART OF COURSE ',F10.2)
      99 FORMAT(' EXCESS NO. OF STUDENT POSITIONS',9X,F10.2)
     100 FORMAT(' INSTR./STUDENT POS. RATIO',15X,F10.3)
     101 FORMAT(' SQ FT/INSTR. POS.',23X,F10.1)
     102 FORMAT(' SQ FT/STUDENT POS.',22X,F10.1)
     103 FORMAT(' UPDATE FACTOR',27X,F10.2)
     104 FORMAT(' HOURLY COST OF IMD',22X,F10.2)
     105 FORMAT(' SALARY OF ONE INSTR.',20X,F10.2)
     106 FORMAT(' SUPPLIES COST/STUDENT',19X,F10.2)
     107 FORMAT(' LIFE OF STUD POS EQUIP  ',16X,F10.1)
     108 FORMAT(' VALUE OF IM AT END OF PLANNING PER.',5X,F10.2)
     109 FORMAT(' STUDENT SALARY',26X,F10.2)
     110 FORMAT(' DISCOUNT RATE',27X,F10.2)
     111 FORMAT(' EQUIPMENT IMPLEMENTATION COST/STUD POS  ',F10.2)
     112 FORMAT(' EQUIP. IMPLEM. COST INDEPEND. STUD POS  ',F10.2)
     113 FORMAT(' FACILITIES ACQUISTION OR REFURBISH COST ',F10.2)
     114 FORMAT(' PER CENT OF TRAINING MEDIUM TIME'/' REQUIRING UNIQUE HOUR00021700
        1S OF IMD',11X,F10.2)                                           00021750
     115 FORMAT(' AVE. HRS/WK. SPENT IN TRAINING MEDIUM   ',F10.1)
     116 FORMAT(' LIFE OF IMPLEMENTATION EQUIPMENT',8X,F10.2)
     117 FORMAT(' EXPECTED LIFE OF FACILITIES (YEARS)',5X,F10.2)
     118 FORMAT(' TOTAL SQ FT REQUIRED FOR ADMIN OVERHEAD ',F10.2)
C        OUTPUT FORMATS
     711 FORMAT(//,' AVE. ANNUAL STUDENT INPUT',15X,F10.2)
     712 FORMAT(' PRESENT COST OF ALTERNATIVE',9X,F14.2)                00022800
     713 FORMAT(' NONDISCOUNTED COST OF ALTERNATIVE  '1X,F14.2)
     714 FORMAT(' AVE. DISCOUNTED COST/GRADUATE',11X,F10.2)
     715 FORMAT(' NONDISCOUNTED COST/GRADUATE',13X,F10.2)
     716 FORMAT(' AVE. DISCOUNTED COST/STUDENT POSITION   ',F10.2)
     717 FORMAT(' INITIAL EQUIPMENT ACQUISTION COST    '    ,F14.2)
     718 FORMAT(' INITIAL FACILITIES ACQUISTION COST      ',F10.2)
     719 FORMAT(' INITIAL IM DEV COST',21X,F10.2)
     720 FORMAT(' INITIAL SYSTEM ACQUISTION COST'/' FOR FACILITIES,EQUIP,AN
        1D IMD', 8X,F14.2)
     721 FORMAT(' REMAINING VALUE OF EQUIPMENT',12X,F10.2)
     722 FORMAT(' REMAINING VALUE OF IM',19X,F10.2)
     723 FORMAT(' NO. OF INSTRUCTORS REQUIRED',13X,F10.2)
```

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A FORTRAN IV (VER S43) SOURCE LISTING: DTE001  PROGRAM        04/10/75      PAGE  0007

      724 FORMAT(' NO. OF STUDENT POSITIONS',16X,F10.2)
      725 FORMAT(' FACILITY REQUIREMENTS IN SQ FT',10X,F10.2)
      726 FORMAT(' AVE. ANNUAL NONDIS. COST/STUD POS',7X,F10.2)
      727 FORMAT(' AVE. ANNUAL DISCOUNTED COST/STUD POS     ',F10.2)
      728 FORMAT(' ACQUISTIION COST/STUD POS ',14X,F10.2)
      729 FORMAT(' AVE. ANNUAL NO. OF STUDENTS ON BOARD',4X,F10.2)            00021750
      730 FORMAT(1H0)                                                         00023950
      731 FORMAT(' UNIFORM ANNUAL COST',17X,F14.2)
          END
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTE081  SUBROUTINE     04/10/75     PAGE  0008

      SUBROUTINE DTE081(L,M)
C                                                                       00021940
C     THIS SUBROUTINE PRINTS OUTPUT ARRAYS                              00021950
C                                                                       00021960
      COMMON STUD(30),FCOST(30),TAEQC(30),AIMMC(30),CINSTR(30),SUPPY(30)
     1,SSALRY(30),UDACST(30),T(30),NUM(30),AOB(30)                     00001500
      K=6
      WRITE(K,700)L,M
      WRITE(K,710) (NUM(I),I=L,M)
      WRITE(K,701) (STUD(I),I=L,M)
      WRITE(K,712) (AOB(I),I=L,M)                                       00025100
      WRITE(K,702) (FCOST(I),I=L,M)
      WRITE(K,703) (TAEQC(I),I=L,M)
      WRITE(K,704) (AIMMC(I),I=L,M)                                     00025400
      WRITE(K,705) (CINSTR(I),I=L,M)                                    00025500
      WRITE(K,706) (SUPPY(I),I=L,M)
      WRITE(K,707) (SSALRY(I),I=L,M)                                    00025700
      WRITE(K,708) (T(I),I=L,M)                                         00025800
      WRITE(K,709) (UDACST(I),I=L,M)                                    00025900
      WRITE(K,711)
C
C     PRINTER OUTPUT DATA FORMAT CODES
C
  700 FORMAT(1H0,T50,'OUTPUT SUMMARY YEARS'I2,'-',I2)
  701 FORMAT(1H0,'STUDENT INPUT',27X,9F10.1)
  702 FORMAT(' NONDISCOUNTED ANNUAL FAC. COST',10X,9F10.0)
  703 FORMAT(' NONDISCOUNTED ANNUAL EQUIPMENT COST ',4X,9F10.1)
  704 FORMAT(' NONDISCOUNTED ANNUAL IM COST'12X,9F10.1)
  705 FORMAT(' NONDISCOUNTED ANNUAL INSTR. COST ',7X,9F10.1)
  706 FORMAT(' NONDISCOUNTED ANNUAL SUPPLY COST ',7X,9F10.1)
  707 FORMAT(' NONDISCOUNTED ANNUAL STUDENT SALARIES   ',9F10.1)
  708 FORMAT(' NONDISCOUNTED ANNUAL TRAVEL COST',8X,9F10.1)
  709 FORMAT(' NONDISCOUNTED ANNUAL OPERATION COST'5X,9F10.1)
  710 FORMAT(' YEAR',42X,I2,8(8X,I2))
  711 FORMAT(1H0)
  712 FORMAT(' AVE. NO. OF STUDENTS ON BOARD',11X,9F10.1)              00024950
      RETURN
      END
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTEOA1  SUBROUTINE     04/10/75     PAGE  0009

          SUBROUTINE DTEOA1(L,M,NUM1)
    C
    C     SUBROUTINE TO PRINT INPUT ARRAYS
    C
          DIMENSION NUM1(18)
          COMMON/INVAR/GRAD(30),CPSQFT(30),COPMT(30),CAQSP(30),UIMDYR(30),OM
         1FEQ(30),RLOFEQ(30)
          K=6
          WRITE(K,10) (NUM1(I),I=L,M)
          WRITE(K,11) (GRAD(I),I=L,M)
          WRITE(K,12) (CPSQFT(I),I=L,M)
          WRITE(K,13) (COPMT(I),I=L,M)
          WRITE(K,17) (OMFEQ(I),I=L,M)
          WRITE(K,14) (CAQSP(I),I=L,M)
          WRITE(K,18) (RLOFEQ(I),I=L,M)
          WRITE(K,15) (UIMDYR(I),I=L,M)
          WRITE(K,16)
          RETURN
       10 FORMAT(' YEAR',42X,I2,8(8X,I2))
       11 FORMAT('0GRADUATES REQD./YEAR',20X,9F10.1)
       12 FORMAT(' COST/SQ FT.',29X,9F10.2)
       13 FORMAT(' OPERATION AND MAINT. COST/YR.',11X,9F10.2)
       14 FORMAT(' ANNUAL ACQUISTION COST/STUD. POS', 8X,9F10.2)
       15 FORMAT(' UNIQUE HOURS OF IMD/YR',18X,9F10.1)
       16 FORMAT(1H0)
       17 FORMAT(' O&M COST OF FIXED EQUIPMENT',13X,9F10.2)
       18 FORMAT(' EXPECTED LIFE OF CAQSP(I) ASSETS',8X,9F10.1)
          END
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTEOC1  SUBROUTINE     04/10/75      PAGE  0010

            SUBROUTINE DTEOC1(KCT)
      C
      C     ARGUMENT 1 - KCT - NO. OF RUNS
      C
      C     THIS SUBROUTINE PRINTS A SUMMARY TABLE
      C
            DIMENSION LABEL(75,7)
            COMMON /TABLE/ TDATA(15,8)
      C
      C     INITIALIZE SUBROUTINE VARIABLES
      C
            ISTART=1
            IEND=4
            IHEAD=1
      C
      C     BUILD LABEL TABLE
      C
            IS=1
            IHALT=5
          2 DO 9 I=IS,IHALT
          9 READ(5,10,END=3) (LABEL(I,J),J=1,7)
            IS=IS+5
            IHALT=IHALT+5
            GO TO 2
          3 IF(IHEAD.NE.1) GO TO 4
            WRITE(6,15)
            WRITE(6,19)
            WRITE(6,11)
            WRITE(6,12)
            WRITE(6,13)
            WRITE(6,14)
            WRITE(6,19)
            IHEAD=2
            GO TO 5
        4   IF(KCT.GT.3) WRITE(6,15)
            WRITE(6,19)
            WRITE(6,16)
            WRITE(6,17)
            WRITE(6,18)
            WRITE(6,19)
            IHEAD=3
          5 IS=1
            IHALT=5
            DO 50 K1=1,KCT
            WRITE(6,20)
            DO 6 I1=IS,IHALT
            IF(I1.NE.IS+2) GO TO 7
            WRITE(6,21) (LABEL(I1,J),J=1,7), (TDATA(K1,J),J=ISTART,IEND)
            GO TO 6
          7 WRITE(6,22) (LABEL(I1,J),J=1,7)
```

```
A FORTRAN IV (VER S43) SOURCE LISTING: DTFOC1  SUBROUTINE     04/10/75     PAGE  0011
    6 CONTINUE
      WRITE(6,20)
      WRITE(6,19)
      IS=IS+5
      IHALT=IHALT+5
   50 CONTINUE
      IF(IHEAD.EQ.3) RETURN
      ISTART=5
      IEND=8
      GO TO 3
   10 FORMAT(7A4)
   11 FORMAT(' *',T32,'*',T42,'PRESENT',T57,'*   AVERAGE DISCOUNTED   *'
     1,T91,'UNIFORM',T107,'*    ACQUISTION COST     *')
   12 FORMAT(' *',T32,'*',T43,'COST',T57,'*   COST PER GRADUATE    *',T8
     19,'ANNUAL COST',T107,'* FOR FACILITIES ,EQUIP. *')
   13 FORMAT(' *',T32,'*',T57,'*',T82,'*',T107,'*   AND INSTRUCTIONAL
     1 *')
   14 FORMAT(' *',T32,'*',T57,'*',T82,'*',T107,'* MATERIAL DEVELOPEMENT
     1 *')
   15 FORMAT(1H1)
   16 FORMAT(' *',T32,'*',T42,'NO. OF',T57,'*','    NON-DISCOUNTED
     1*    NO. OF STUDENT      *   AVERAGE HOURS PER    *')
   17 FORMAT(' *',T32,'*',T39,'INSTRUCTORS',T57,'*   ANNUAL INSTRUCTOR
     1  *  POSITIONS REQUIRED    *  GRADUATE IN MODULE    *')
   18 FORMAT(' *',T32,'*(IN MAN-YEARS PER YEAR) *',T67,'COST',T82,'*',T1
     107,'*',T132,'*')
   19 FORMAT(1H ,32('****'),'***')
   20 FORMAT(' *',T32,'*',T57,'*',T82,'*',T107,'*',T132,'*')
   21 FORMAT(1H ,7A4,'  *',4(5X,F14.1,5X,'*'))
   22 FORMAT(1H ,7A4,'  *',4(24X,'*'))
      END
```

```
A FORTRAN IV (VER S43) SOURCE LISTING:  DTEOD1  SUBROUTINE     04/10/75     PAGE  0012

          SUBROUTINE DTEOD1(MED,LC)
C
C         THIS SUBROUTINE STORES OUTPUT TABLE VALUES
C
          COMMON /OVAR/CDATA(20)
          COMMON/TVAR/ X(15,8,20)
          DO 1 I=1,20
        1 X(MED,LC,I)=CDATA(I)
          RETURN
          END
```

```
A FORTRAN IV (VER S43) SOURCE LISTING:                        04/10/75     PAGE  0013
      SUBROUTINE DTERE1
C
C     THIS SUBROUTINE PRINTS A TABLE
C
      COMMON /TVAR/ X(15,8,20)
      DIMENSION IVAR(19),ICAT(16),MEDIA(15,4)
C
C     READ CATEGORY HEADINGS AND NO. OF MEDIA CARDS
C
      READ(5,16) (ICAT(I),I=1,16),NCT
      IST=1
      IEND=5
      ICT=0
    3 READ(5,17) ((MEDIA(I,J),J=1,4),I=IST,IEND)
      ICT=ICT+1
      IF(ICT.EQ.NCT) GO TO1
      IST=IST+5
      IEND=IEND+5
      GO TO 3
C
C     READ TABLE VARIABLE AND NO. OF MEDIA TO BE PRINTED
C
    1 READ(5,10,END=100) (IVAR(I),I=1,19),NVAR,NMED
      WRITE(6,11) (IVAR(I),I=1,19)
      WRITE(6,12)
      WRITE(6,13)
      WRITE(6,14) (ICAT(I),I=1,16)
      WRITE(6,13)
      WRITE(6,12)
      DO 2 K=1,NMED
      WRITE(6,13)
      WRITE(6,15) (MEDIA(K,J),J=1,4),(X(K,LC,NVAR),LC=1,8)
      WRITE(6,13)
    2 WRITE(6,12)
      GO TO 1
  100 RETURN
   10 FORMAT(19A4,2I2)
   11 FORMAT(1H1,19A4,//)
   12 FORMAT(1H ,31('****'),'*')
   13 FORMAT(' *',T22,'*',8(12X,'*'))
   14 FORMAT(' *',T22,'*',8(2X,2A4,2X,'*'))
   15 FORMAT(' *',2X,4A4,' *',8(1X,F10.1,' *'))
   16 FORMAT(16A4,8X,I2)
   17 FORMAT(20A4)
      END
```

```
                                                                  *** DATA DECK LISTING ***
111
RUN ID : EXAMPLE 1                                                                      1   1
INSTRUCTIONAL DELIVERY SYSTEM - OPERATIONAL SYSTEM IN A LABORATORY WITH TUTOR
0.        0.        64.       75.       100.      0.        0.        3000.     10.       .01
1.0       0.20      0.        30.       1.0       16240.    0.        11141.    0.        0.
10.       0.04      0.10      50.       0.1       3.        0.        0.        0.05
2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
150.      150.      150.      150.      150.      150.      150.      150.      150.      150.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
1300.     1400.     1300.     1200.     1200.     1100.     1100.     1100.     1100.     1100.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
RUN ID : EXAMPLE 2                                                                      2   6
INSTRUCTIONAL DELIVERY SYSTEM - MICROFISHE WITH PHOTO MOCKUP
0.        0.        64.       75.       100.      0.        0.        275.      10.       .01
1.        .20       0.        1134.     .1        16240.    0.        11141.    0.        0.
10.       .04       .10       50.       .1        4.        .05       .1        .05
2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75      2.75
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
15.       15.       15.       15.       15.       15.       15.       15.       15.       15.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
1300.     1400.     1300.     1200.     1200.     1100.     1100.     1100.     1100.     1100.
0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
END OF FILE INDICATOR
*         SYSTEM A
*
* OPERATIONAL SYSTEM IN A
* LABORATORY WITH TUTOR
*
*         SYSTEM B
*
*  MICROFISHE WITH PHOTO
*  MOCKUP
*
END OF FILE INDICATOR
 CAT 1    CAT 2    CAT 3    CAT 4    CAT 5    CAT 6    CAT 7    CAT 8          1
   OP. SYSTEM       MICROFISHE          CAI              PT LINEAR     PT BRANCHING
NONDISCOUNTED COST PER GRADUATE - EXAMPLE 1                                      6 3
NONDISCOUNTED COST OF ALTERNATIVE                                                4 3
INITIAL INSTRUCTIONAL MATERIAL DEVELOPEMENT COST                                10 3
END OF FILE INDICATOR
END OF FILE INDICATOR
                                                        **** END OF LIST ****


**FORTRAN ** STOP
```

ATTACHMENT 1

COST DATA COLLECTION FORM

COST DATA COLLECTION FORM

Instructional Delivery System________________________

Run ID____

Symbol	Variable Description	Value	Units
Facilities			
FACOST	Total facilities acquisition and/or refurbishing costs		Dollars
LOFFA	Expected years of life of FACOST assets (in whole numbers)		Years
SQFTIN	Total square feet required for each instructor		Sq ft
SQFTST	Total square feet required per student position		Sq ft
SQFTAM	Total square feet required for administrative overhead for all student positions		Sq ft
Equipment			
EQCISP	Equip. implementation costs independent of stud. pos.		Dollars
LOFEQ1	Expected years of life of EQCISP assets		Years
EQIMPC	Equip. implementation costs per student position		Dollars
LOFEQ	Expected years of life of EQIMPC assets (in whole numbers)		Years
TSPOSD	Percent of operating time student position down		Percent

Symbol	Variable Description	Value	Units
Instructional Material (IM)			
UIMD	% of TLENGH (i.e., time spent in training medium) for which new instructional material must be developed		Percent
UPDATE	% of original development cost required each year to maintain instructional material		Percent
EVIM	% of original development cost remaining at end of planning period		Percent
CIMD	Average cost of developing one hour of instructional material		Dollars
Personnel			
INTSPO	Instructor to student position ratio		Decimal Ratio
SALINR	Annual salary and benefits of one instructor		Dollars
Supplies			
SUPPLY	Cost of expendable supplies for each student while enrolled in course		Dollars
Students			
STUDSL	Annual salary and benefits of one student		Dollars
STCST1	Average student travel cost to and from school		Dollars
STCST2	Average per student travel cost as a part of course		Dollars
Miscellaneous			
N	Number of years in planning period		Years
ARATE	Attrition rate		Percent
DRATE	Discount rate		Percent
WSCHOP	Weeks school operates each year		Weeks
TLENGH	Average time spent in training medium per student (non-recycled students)		Weeks
TLEGTH	Average hours per week student spends in medium		Hours
RCRATE	Recycle rate		Percent
ARCYTM	Average time the recycled student spends repeating material		Weeks
ESP	Percentage of excess student positions required to provide for fluctuations in input		Percent

NOTE: All percent values are entered as decimal equivalents.

SYMBOL	VARIABLE	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10
		YR 11	YR 12	YR 13	YR 14	YR 15	YR 16	YR 17	YR 18	YR 19	YR 20
Facilities CPSQFT(I)	Cost/Ft^2 for Facilities Per Year (Dollars)										
Equipment CAQSP(I)	Equipment Acquisition Cost/Student Position										
LOFEQ(I)	Expected Life of CAQSP(I) Assets (Years)										
COPMT(I)	Operation and Maint. Cost of Equipment Per Student Position for Each Year (Dollars)										
OMFEQ(I)	O & M Costs of Fixed Equipment (Dollars)										
Students UIMDYR(I)	Unique Hours of IMD Per Year (Hours)										
Instructional Material GRAD(I)	No. of Graduates Required for Each Year (Number)										